STUDIES IN GEOGRAPHY 2

APPLIED GEOGRAPHY IN HUNGARY

AKADÉMIAI KIADÓ, BUDAPEST

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(STUDIES IN GEOGRAPHY NO. 2)

This volume aims at giving a comprehensive view of the latest results obtained by novel methods in the most important fields of applied geography. Papers on physical geography introduce the reader to the present state of geomorphological and soil-erosion mapping in Hungary. The processes resulting in the formation and spread of alkali soils—a major problem of Hungarian agrotechnics — are explained from the geographer's angle, and information is given on the amelioration work. The irrigation facilities in the large sandy areas of the Great Hungarian Plane are also dealt with. Investigations carried out by the methods of applied geography endeavour to disclose interconnections between the location of social production and geographical distribution of productive population, industrialization and internal migration, urbanization and agricultural over-population. The geographical types of agriculture and industry are determined and evaluated in view of the requirements of national economy.

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AUTHORS

MÁRTON PÉCSI
SÁNDOR MAROSI
JENŐ SZILÁRD
SÁNDOR SOMOGYI
GYÖRGY ENYEDI
ISTVÁN ASZTALOS
LÁSZLÓ SIMON
BÉLA SÁRFALVI
EDIT LETTRICH
IMRE BENCZE
GYÖRGY MARKOS

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Translated
by
BÉLA KECSKÉS

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ABBREVIATIONS IN THE BIBLIOGRAPHY

AgEÉK	= Agrártudományi Egyetem Évkönyve
AgT	= Agrártudomány
BOK	= Magyar Tudományos Akadémia Biológiai Osztályának Közleményei
CSAV	= Československá Akadémia Věd
Dem.	= Demográfia
FÉ	= Földrajzi Értesítő
FK	= Földrajzi Közlemények
FKCs	= Magyar Tudományos Akadémia Földrajztudományi Kutatócsoport
FKCsEMV	= Földrajztudományi Kutatócsoport Elméleti és Módszertani Vitaanyagai
FKTÉ	= Földrajzi Könyv- és Térképtár Értesítője
FM	= Földrajzi Monográfiák
FtIÉJ	= Földtani Intézet Évi Jelentése
FtIÉK	= Földtani Intézet Évkönyve
FtK	= Földtani Közlöny
GK	= Geodézia és Kartográfia
HK	= Hidrológiai Közlöny
MFK	= Magyar Földrajzi Konferencia
MSzKt	= Magyar Szemle Kincsestára
PAN	= Polska Akadémia Nauk
St Sz.	= Statisztikai Szemle

GEOMORPHOLOGICAL MAPPING IN HUNGARY IN THE SERVICE OF THEORY AND PRACTICE

by MÁRTON PÉCSI

Aspects concerning science and economy

The detailed and systematic geomorphological mapping, whose research methods and theoretical conceptions have fundamentally broadened, owing to an urgent demand for the complex representation of the surface reliefs, exerts — as shown by initial results — a very favourable and stimulating influence on the development of geomorphology as a discipline.

As a matter of fact, geomorphological investigations in Hungary have hitherto been characterized, on the one hand, by an exaggerated morphogenetic research trend. The geomorphological investigations into geomorphological districts or physiographic landscapes aimed chiefly at interpreting the history of surface evolution in detail.

Consequently, geomorphology remained, at least as far as its research methods and the content of its results are concerned, part and parcel of geology, even in cases when, say, a study on the sedimentational and morphogenetic effects of some Quaternary processes was carried out by a geographer in place of a geologist (Quaternary morphology — Quaternary geology).

On the other hand, our geomorphological investigations were characterized by a conspicuous specialization. Syntheses important from both the national and international point of view have been fairly well accomplished in terrace morphology (Schafarzik, Kéz, Bulla, Sümeghy, Láng, Pécsi, Székely, etc.), karst morphology (Cholnoky, Kessler, Láng, Szabó, Jakucs, Leél-Össy), blown-sand and loess morphology (Lóczy, Cholnoky, Bulla, Kádár, Sümeghy, Miháltz, Ádám, Marosi, Szilárd, Borsy), and periglacial morphology (Szádeczky-Kardoss, Bulla, Kerekes, Pécsi, etc.). But a truly complex geomorphological study of the Hungarian landscapes, disregarding a few unsuccessful attempts, has been delayed, although the climatico-geomorphological approach became predominant during the last two decades. As long as the main interest of the geomorphologists working in the terrain was restricted to traditional surface research, "white spots", other phenomena or features in the areas investigated were necessarily left unexplained. However, since geomorphological field research was coupled with geomorphological mapping, the geomorphological interpretation of the relief has changed at a quick pace. The goals and methods of research have broadened so as to yield manifold and quite ample possibilities for solving the practical economic problems, too. Now, corresponding to the new conception and the legend of detailed geomorphological mapping, an expert carrying on a complex geomorphological survey cannot further his field work without paying attention to the rocks making up the reliefs of different genesis and quality, to their relationship with the surface features, to the qualitative and quantitative bearings of the processes modelling the various portions of the surface, and to the chronology of spacial changes in surface and climatic elements and all their interrelations. He has to consider the changes which had taken place and are taking place on the slopes of surface forms. In doing so, he will evaluate the dynamism of denudation of the soil, which cannot be accomplished without a knowledge of the geographical conditions of soil and plant. In addition, his observations must extend to the surface changes concomitant with social production (agriculture, industry, etc.), as well as to the possible changes other human activities — building, canalization, irrigation, water storage, or other physical processes — may cause in the physiographic landscape, i.e. in the relief. Thus the aims and methods of geomorphological research have been considerably amplified, and, in fact, geomorphology as a science has become much more effective by the application of the principles of geomorphological mapping according to the above requirements. After all, geomorphological mapping necessarily involves a geomorphological synthesis, as well as a multilateral, qualitative and quantitative representation of the physiognomy of the physical environment.

While elaborating the principles of a detailed geomorphological mapping of Hungary and the methodology of a cartographic representation, it was our purpose to develop such detailed geomorphological maps as may include comprehensive economic evidence which may be readily relied on in planning agricultural soil protection, in preparing soil maps and engineering-geological maps, in drafting projects for developing towns, industrial branches and road systems. In addition, these maps should give important and useful information as to irrigation, flood control, land utilization and afforestation plans. All these data and records can be directly read off the geomorphological map, or can be obtained by calculations and, occasionally, by correlating them with factors borrowed from other sources.

For instance, the drainage basin of a minor valley system can be easily recognized on a geomorphological map plotted for a rolling country-side. The slope conditions of the valley system (angles of slope, scarps undergoing aggradation or degradation, etc.) and the rocks making up the slopes (slope loess-loam, etc.) can also be read off. In addition, one can easily make computations as to the approximate quantity of mud accumulating in a given section of the valley floor from the waters of the drainage area of the valley system, or measure the rate of flow after abundant rainfalls, etc.

Geomorphological mapping in the service of practical life has considerably aided geomorphology in setting up the principles and developing the methodology of *applied geomorphology*. Consequently, geomorphological maps are now ranked with geological, engineering-geological and pedological maps which provide fundamental information for regional economic development based on the most recent scientific researches.

Synoptic geomorphological mapping
(scale 1 : 100,000 and 1 : 200,000)

In preparing the synoptic geomorphological map sheets, it has been our aim to yield a synthetic, dynamic representation of the complex geomorphological conditions of each major region of Hungary. These maps are segmented in the internationally adopted Gauss—Krüger projection on scale of 1 : 100,000.

These segments are reproduced, by slight modifications, on sheets of 1 : 200,000 scale so that together with the geological and pedological maps of similar scale they may help the scientists in revealing the physical soil conditions of Hungary in the interconnection of research and practice, and aid the expert in planning economy on a scientific basis. The geomorphological map sheets of 1 : 200,000 scale also provide an aid for a more precise delimitation of the geomorphological regions of the country, which is one of the most important criteria of physiographical landscape zonation.

Although the basic conceptions of our synoptic map do accord with those of a detailed geomorphological map, its legends and content naturally differ in scale and function.

The data recorded on the *synoptic geomorphological maps* are as follows:

I. Various types of the form assemblages making up the relief of the country, such as plains, planated surfaces and mountains, and the lithological properties of the rocks that had had an important role in building up these form assemblages
II. Individual genetic forms
III. Processes shaping the surface features, the slopes
IV. Age of the surface features
V. Noteworthy morphometric and hydrogeographic elements in the relief.

This manifold content of our synoptic geomorphological maps could naturally be recorded only by applying appropriate cartographic methods and by combining symbols and signs. It is admitted that a synoptic map yields a rather bulky representation of the geomorphological characteristics on individual features, etc., but, on the other hand, its content as compared with that of a detailed geomorphological map sets off the clear outlines of the major form assemblages. Of the content of our synoptic geomorphological maps, only the interpretation of this category will be discussed here. (The additional four categories [II to V] will be treated in a chapter to follow, dealing with detailed geomorphological mapping.)

In classifying major form assemblages, the morphological conditions of Hungary were held in view. Accordingly, two major structural-morphological form assemblages have been distinguished: (A) the different types of the planated surfaces — plains and (B) those of the mountains.

(A) Planated surfaces — plains

These form assemblages were classified into three main groups according to the processes that played the predominant role in their formation.

(a) We have distinguished the sub-group of alluvial plains and talus plains as perfect ones. These vast plains had undergone fluviatile accumulation since the close of the Pleistocene epoch and represented flood plains, marshy-waterlogged areas, up to the last century, when anti-inundation work was undertaken. (They are recorded by a greenish-blue raster on which some ten lithological varieties have been indicated. The signs and symbols of the individual genetic forms, the drainage system, the morphometry and the age of the surface have been superimposed.)

(b) The talus plains and planated surfaces covered by eolian sediments have been united in another type of plains.

The Hungarian plains covered by eolian sediments lie higher than the flood plains of the rivers, but their relative altitude does not exceed 200 m anywhere. The platforms have been transformed to undulating hill landscapes dissected by broad valleys in the Transdanubian Hill Country, where the slopes are covered by mantle-like loose slope loesses and slope loams. (The basic colour of this category is represented by various yellowish raster shades.)

(c) The planated surfaces, denuded surfaces of Tertiary loose marine deposits or of still older gravelly talus fans (Marcal Basin, Kemeneshát, higher gravel sheets) degraded by recent processes, chiefly by those in the Quaternary period, have been included in a separate sub-group. (The basic colouring consists of horizontal streaks, which are either greenish-blue or yellowish or ochre-colour or a combination of these according to the forces that had prevailed in sculpturing the surface.)

The signs of the minor peneplain surfaces, peneplain steps and pediments of the mountains figure among the individual genetic forms, because they cover only small areas on the synoptic map.

(B) Mountain Types

(a) The peneplanated volcanic mountains form the first sub-group. (The basic colouring consists of a vermilion raster, the lithology being represented by grey graphic signs.)

(b) The sub-group of the peneplanated fractured (folded) block mountains includes the central mountains made up chiefly of Mesozoic rocks. (Basic colouring by light violet raster.)

(c) The ruined remnants of the Variscian orogen were ranked as a sub-group of peneplanated ancient block mountains. (Basic colouring by light carmine raster.) Within the various mountain types, the individual genetic forms and slope conditions are recorded by symbols and graphic signs as true to scale as possible, while the ages of the surface features by letters.

The signs reflecting the lithology, e.g. the oblong signs of limestone, can be recorded in a spotlike pattern, so that they may not disturb the signs of other features. In doing so, however, we have to take care that the lithology shall still be recognizable.

Detailed geomorphological mapping
(scale 1 : 10,000—1 : 25,000)

While designing the content and legend of the detailed geomorphological maps, we aimed at having the results of geomorphological investigations reflected most profitably for both science and economy. The content of the maps has to be represented in such a cartographic way that it should be easy to survey for economic planners.

As to content, a detailed geomorphological map does not essentially differ from a synoptic map, but the latter represents the features and phenomena more consistently and true to scale.

(1) The principle that our detailed geomorphological maps reflect the lithological properties of the relief as a whole, or those of the individual surface features, in particular, concerns the requirements of both scientific research and economic life. It is well known that surface features of the same genesis show different characteristics according to the quality of the rocks, and the configuration of the surface varies widely, too, depending on the rock quality.

For experts engaged in soil engineering and soil mechanical — melioration — etc. planning it is not necessary to emphasize the importance of having a comprehensive knowledge of the lithological composition of surface rocks.

The legend combines the denotation of surface lithology with that of the processes responsible for the formation of the rocks. The lithological properties of the latter are represented by graphic signs, according to international practice. The petrogenetic processes are illustrated by different light shades of raster colours.

It is not a contradiction that the basic tonality on our geomorphological map gives relief to the dynamism of the formations covering the surface. All the less so since a detailed geomorphological map has to reflect the dynamism of the morphological evolution which traces back to the formation of the substratum. Thus, we have to get acquainted with the processes that formed the rocks making up the surface and also with those that keep on modelling the relief atop this substrate. (For instance, eolian sediments are being dissected by processes of fluviatile erosion; or gravitation-erosion processes are acting on the surface of Tertiary marine clays.)

This principle must be followed in any case when accumulation forms are to be represented on genetic geomorphological maps. Then we must not fail to denote whether the forms we are dealing with had been produced by fluviatile or eolian or other processes.

In addition, the basic colour, by means of a common shade, renders perspicuous the formations and the accumulation forms which, though different in lithological composition, are results of the same process (e.g. fluviatile, eolian, accumulation, etc.).

With a view to Hungarian conditions, the following groups of rock formations are distinguished by the legend:

Igneous rocks:	effusive and intrusive (red)
Metamorphic rocks:	orthometamorphic and parametamorphic (rose)
Sedimentary rocks:	(a) eluvia (grey)
	(b) talus deposits (ochre)
	(c) fluviatiles (greenish-blue)
	(d) lacustrine (pale-blue)
	(e) fluvio-lacustrine (bluish-green)
	(f) marine (purplish-blue)
	(g) eolian (yellowish)
	(h) biogenic (deep-green)
	(i) anthropogenic (brownish-grey)

The legend lists 70 rock types out of the varieties of formations brought about by these processes, but further signs can be combined for particular cases (e.g. sandy gravel, sandy clay, etc.).

(2) On our detailed geomorphological map the symbols of the processes modelling the Earth's surface and the individual surface features have been combined with the signs of the genetic form types and slopes. The slopes are indicated by hachure plotted in a direction corresponding to the inclination of the surface. Its thickness has three categories, each of them answering to a given slope angle. The shade of the hachure is changed for each particular process modelling the slope. (For instance, the slopes modelled by fluvial erosion are represented by vivid bluish-green, those modelled by deflation by orange, and the gravitation-solifluction slopes by red-brown hachure.) The consistency is expressed either by solid hachure (aggraded slope) or by broken hachure (degraded slope) or by a doubled solid one (stable rocky slope).

The figural-lineal signs of the individual genetic surface features also differ in colour according to the processes involved (see below).

If the slopes or forms were modelled by two predominant processes, the lines are combined in colour. If, however, the slope or surface feature was shaped or re-modelled by more than two processes, and the ratio cannot be detected, black signs are used (polygenetic complex features).

The lineal signs are vivid-coloured. This kind of notation on a paler-coloured basic map sheet, as discussed under the previous heading, demonstrates the trends of evolution and the dynamism of relief and surface features. For example, if in a mountain built up of volcanic rocks (red basic colour), peneplain surfaces had been formed in the Tertiary period (ochre signs), and then they were dissected by erosion valleys and slopes, then we apply vivid bluish-green signs.

(3) The legend of the detailed geomorphological map classifies the genetic surface features according to the morphogenetic processes and includes the recent or fossil elements occurring in Hungary.

(A) Features produced by internal agents:
- (a) intrusion features exposed by denudation
- (b) monoclinal features
- (c) folded features
- (d) faulted and fractured features
- (e) volcanic features

All these features are represented by vivid carmine symbols.

It is also advisable to evaluate the relevant data of the geological maps and investigations while determining the folded, faulted and fractured features.

(B) Recent investigations brought to light data proving that gravitation, fossil ice-fragmentation, solifluction, cryoturbation and corrasion had played an important role in sculpturing the relief of Hungary. (Notation: red-brown.) It is just on this account that the legend shows these features in detail. The broad, drainless corrasion valleys represent the overwhelming majority of valleys in rolling landscapes. Therefore, it is just as important to differentiate their types as in the case of erosion valleys.

In the rolling regions of Hungary the cultivated slopes covered by loose material are subjected to destruction throughout the surface by winter frost and spring thawing waters (recent corrasion slopes). This process is a very important agent of soil destruction, sometimes more significant than the furrowing or the grooving erosion which brings about ravines and gullies. We need not emphasize how useful it is also for the economy to detail the gravitational dynamism (landslides, stone streams) of the fossilized slopes.

(C) Features produced by fluvial erosion (notation: vivid bluish-green). This category contains genetic classification as well as quantitative and qualitative data of forms also evaluated with a view to practical requirements. Therefore, the depths of gullies, ravines and river beds and their lithologic composition (sands, gravels or pebbles) are given together with the development stages of ancient meanders and the extent of their water or vegetable covering; the condition, course character and bank types of major river beds (degraded, aggraded, steep, flat banks) are also indicated.

Since the fluvial linear erosion is currently the most effective of the external forces, the legend shows numerous valley types produced merely by erosion.

In addition, there are many places where the corrasion valleys formed under the dry-cold periglacial climate of the Pleistocene epoch were remodelled by Holocene processes of linear erosion (corrasion valley re-modelled byerosion).

(D) The deflation features—dark-yellow and orange symbols—can also be mapped over wide areas. Loosely-fixed blown-sand features, due to accumulation by wind, are not unknown in Hungary, and they also have been thoroughly investigated.

Nowadays, sand movement takes place only in extremely dry winters and early springs in areas covered with loosely-fixed sands. Sand blankets and dune features liable to such dynamisms are indicated by the letter R (recent). Of the loess features in Hungary, those representing the so-called "plateau loesses" or covering blown-sand features are considered to be of eolian origin, but the valley and slope loess form varieties are usually not (see talus deposits).

The features brought about on non-blown-sand surfaces by wind destruction (wind-corrasion features; mushroom-rocks, steep stacks and rocky scarps) were included in the corrasion, cryofraction form group, as the initiative in their formation has been contributed to the rock-fragmenting and gravitational processes of the dry-cold periglacial climate.

(E) The abrasion features—light-blue signs—do not play an important part in the relief of Hungary. During the Holocene epoch considerable lacustrine abrasion features and levels, barrier beaches, lagoons, limans were formed along the shores of some major lakes of Hungary, e.g. Lake Balaton. It has not yet been adequately clarified as to how many and how large were the abrasion terraces and levels which were incised on the borders of the Hungarian Central Mountains by the Tertiary inland seas. Several research workers have recorded such formations, but their exact differentiation from the piedmont steps requires more extended investigation.

(F) The karst-denudation features—dark-green signs—are divided in two groups; in karst features of limestones, and in karst-suffosion features of loesses and loess-like sediments.

Karst features of limestones frequently occur in the Mesozoic Central Mountains, while karst features of loesses are characteristic of the thick loess platforms and slope loesses in the Mezőföld region and Transdanubia, and of the slope loesses in the borders of the Central Mountains. In intensively dissected rolling areas and mountain borders, loess-karsting and suffosion processes do considerable damages to both agriculture—particularly to vineyards and orchards—and road and railway systems, and sometimes even to large buildings. Special studies must be devoted to the mapping of these processes also with a view to the economy. Anyway, limestone karsting and its features have been profoundly investigated, and now their individual categories are easy to map.

(G) The fossil features produced by areal erosion include the remnants of tropical peneplain surfaces and peneplain steps together with the piedmont steps and pediments formed under the influence of the tropical humid or semi-arid climate of the Tertiary epoch. They are fossil feature remnants fading away by destruction in our Central Mountains and in their borders. However, the sloping surfaces connecting the foothills with the basin or valley floors, i.e. the so-called pediments were formed not only at the end of the Tertiary, but also under the conditions of semi-arid cold climate types of the Pleistocene. Moreover, it is often found that the Upper Pliocene pediments were either intensively re-modelled in the Pleistocene, or new pediments were added to them. (The features belonging to this category are shown by ochre signs.)

(H) The group of the features of complex genesis—indicated by signs of combined colours or black—is not an independent category. It is well known that a lot of features are brought about by several kinds of forces. Therefore, the legend presents methodological examples illustrating how features produced by several forces can be expressed in terms of the genetic conception. For instance, if a slope affected by tectonic fracture is destroyed by linear erosion, the parallel red hachure indicating the fracture origin of the slope must be alternated with greenish-blue. If, again, it cannot be established by what forces the destruction of a feature had been caused, the feature is indicated by a black symbol. As a rule, however, we may follow the current practice of representation in which the feature signs may be feasibly combined.

(I) Biogenic and anthropogenic features (black signs). Every anthropogenic form involving terrain accidents either positive or negative, must be represented on the detailed geomorphological map. While plotting dams, embankments and trenches for various purposes, or mine pits, spoil-heaps, quarries, etc., we have to indicate their qualitative and quantitative data as well.

(4) The age of the relief and surface features is also indicated by letters on the detailed geomorphological map. Although a considerable number of foreign geomorphological maps reflect the age of reliefs by basic colouring, we do not believe that such a vigorous representation of the age of surface formations is justified. In fact, it is precisely the determination of the age of the relief that raises most difficulties in geomorphological surveying, as it involves the greatest number of hypothetical elements.

Even individual research workers may differ as to the chronology, which may vary from country to country as well.

With a view to this, our well-proved practice denotes the age of the surface features by letter symbols plotted on each distinct parcel of the surface. Since no pre-Tertiary surfaces and surface features can be found in Hungary, the legend includes symbols referring only to Tertiary or still younger features.

According to our legend, the Quaternary period is divided into three parts. A division into four is also rather current in international practice but we consider that a more detailed division of the Pleistocene epoch is necessary only in the case of terraces. In the mountainous reaches of rivers the number of Pleistocene terraces may amount even to six, when even the division limited to four would present some difficulties. Nevertheless, where a more detailed and exact division is possible, upper indices are applied within each of the three sub-divisions (e.g. Q_1 = pre-Günz—Günz, Q_1' = Günz-Mindel, Q_1'' = = Mindel, Q_2' = Mindel-Riss, Q_2'' = Riss, Q_3' = Riss-Würm, Q_3'' = Würm).

If the age of the surface can be sufficiently determined by referring to it as of Holocene, Pleistocene or Pliocene origin, the corresponding letter symbol is plotted without upper index.

The surface features which are being modelled at present, i.e. the recent ones, get symbol H_3 in red, while the other letter symbols remain black. This distinction aims, in the first place, to attract the attention of the experts of economy. The chronological data of the map also reflect the variances in development and age of the relief portions, as well as the changes taking place at present and their dynamism (e.g., break of banks, landslides, etc.), which are of great interest for economic planners.

(5) Morphometric elements of the relief and hydrography.

On the detailed geomorphological map the contour lines are spaced only by 50 m; but the relative differences in the relief are expressed in two different ways. The quantitative data on the individual genetic forms, such as ravines, erosion furrows, abruptly collapsing bank walls, are indicated by numerals. The relative differences within small distances in the relief are represented separately by isolines indicating the relative height (differences in the relief below 20 m, 20 to 50 m, 50 to 100 m, and above 100 m). This notation provides an easy estimation of the relative altitude of land form and relief in general.

As regards hydrographic data, we put cold and thermal water springs, permanent water streams and canals in three subdivisions. Of the periodical streams only those are indicated which have at least a stable bed. The episodic bedless water streams of the blind creeks and corrasion valleys are disregarded. But the areas waterlogged periodically and those endangered by internal waters must be shown. Information on the position of the groundwater table and relevant profiles are given in the explanatory booklet appended to the detailed geomorphological map-sheets of flatland areas.

Explanatory booklet

To each sheet (occasionally to several sheets of the same character) of the detailed geomorphological map, concise explanatory notes are provided in a supplementary booklet which also may include important profiles and information about the immediate bottom rocks, i.e. the formations underlying the sediments mapped. This is useful for soil-mechanical planning, too. The explanatory notes briefly characterize the geographical position of the region and adjacent areas, their lithological structure and geomorphological evolution; they describe the feature types making up the relief and evaluate the processes, chiefly those presently active or having acted in the recent past in the sculpturing of the surface. The slope morphology and the degree of soil destruction—if there be any—have to be discussed separately. For flatland areas, we have to evaluate the groundwater conditions, while for rolling or mountainous regions the hydrographic condition, together with the possibilities of water accumulation, should be considered. These concise chapters are complemented by a complex evaluation of the physiographical conditions of the area mapped, with special regard to its geomorphology.

Accessory maps, sketches, tables and analyses of rock samples are added as supplements to the explanatory notes. For example, the geomorphological map may be prepared parallel with a *map representing the degree of soil destruction* in rolling landscapes built up of loose sediments, or with a *map of the isolated plain areas damaged by internal waters*, etc. The explanatory notes are completed by a bibliography of the physical and economic geography and geology of the area in question.

The physical conditions may be treated according to the type of the landscape (flat, rolling or mountainous), from the point of view of agricultural production, settlement, communications, tourism and industrial production. In a chapter dealing with landscape analysis it is not the formal but the intrinsic relations of the physiographic environment that should be expounded, i.e. those rather unknown features which are either advantageous or disadvantageous for economy. So we recommend the summing up point by point of our suggestions concerning the particular branches of economy.

As geomoprhological maps are the most effective means by which the evidences of geomorphological and physiographical investigations can be furnished to the people's economy, they form the basis of *applied geomorphology*, one of the disciplines of applied geography.

Bibliography

Ádám, L., Marosi, S., Szilárd, J. (1959) A Mezőföld geomorfológiai térképe (The geomorphological map of the Mezőföld) in *A Mezőföld természeti földrajza*; *FM*, vol. II

Balatka, B., Loučková, J., Sládek, J. (1963) Entwurf einer Konzeption und der Legende für die detaillierte geomorphologische Karte (1 : 50,000—1 : 25,000) *Sbornik Zemépisné*, no. 68, 229—38

(Basanina, Leontiev, Simonov, Viskrebentseva, Zarutskaya) И. П. (1960) Легенда Геоморфологической Карты Советского Союза. Масштаб 1:50,000—1:25,000. МГУ Георг. Факультет. Москва, 25

Басанина Н. В., Леонтьев О. К., Симонов Ю. Г., Вискребенцева В. С. и Заруцкая

Borsy, Z. (1961) A Nyírség geomorfológiai térképe (The geomorphological map of the Nyírség), in *A Nyírség természeti földrajza*; *FM*, vol. V

Tricart, J., Bourdiec, F., Ottmann, L. (1963) Legende des cartes géomorphologiques detailles (1/20,000 et 1/25,000), Université de Strasbourg Centre de Géographie Appliquée; Strasbourg, 35

Demek, J., Czudek, T. (1963) Entwurf der Konzeption und der Legende der geomorphologischen Übersichtskarte der CSSR (1 : 200,000), *Sbornik Zemépisné*, no. 68, 239—56

Füsi, L. (1962) A magyar geomorfológiai térképezés elvi és módszertani kérdései (Principles and methodology of geomorphological mapping in Hungary), *GK*, vol. VIII, 342—6

Gellert, J. F. (1962) Morphogenetische Karte der Deutschen Demokratischen Republik (1 : 200,000), Univ. of Potsdam, 42

Klimasewski, M. (1962) The principles of geomorphological mapping in Poland, *PAN*, 9

Pécsi, M. (1959) A Dunavölgy magyarországi szakaszainak geomorfológiai térképe (Geomorphological map of the Hungarian section of the Danube Valley), *FM*, vol. III, Budapest

Pécsi, M. (1962a) Die geomorphologische Übersichtskarte Ungarns, *MFK*, vol. I

Pécsi, M. (1962b) Tíz év természeti földrajzi kutatásai (Ten years of physicogeographic research *FÉ*, vol. XI, 305—36

Pécsi, M. (1962c) Zeichenschlüssel zu der genetischen geomorphologischen Übersichtskarte Ungarns, *FKCs*, 12

Pécsi, M. (1962d) Entwurf des Zeichenschlüssels der Detaillierten geomorphologischen Kartierung Ungarns, *FKCs*, 19

Pécsi, M. (1962d) A nemzetközi geomorfológiai térképezés helyzete (International geomorphological mapping), *FÉ*, vol. XII, 419—28

Pécsi, M. (1964) Ten Years of Physicogeographic Research in Hungary, Akadémiai Kiadó, Budapest

(Spiridonov) Спиридонов А. Н. (1952) Геоморфологическое картирование. Москва, 185

Waldbauer, H. (1958) Zur Karte: Landformen im mittleren Europa (1 : 2,000,000), des Deutschen Instituts für Länderkunde, Leipzig, 134—77

LANDSCAPE EVALUATION AS AN APPLIED DISCIPLINE OF GEOGRAPHY

by SÁNDOR MAROSI and JENŐ SZILÁRD

The history of landscape research dates from the epoch of A. v. Humboldt, who first developed a conception for modern geographical synthesis. Chief characteristics of his conception were: causality, interaction and synthetic approach to the interrelated physical phenomena. In his works, the description of the physiognomy of the regions studied implies a geographical synthesis demonstrating the interrelations of relief, climate, hydrography as well as the phenomena of life. Accordingly, by a consistent application of the chorological method, Humboldt lays the foundations of landscape analysis; in fact, his physiognomical areal units are what we call physical landscapes. Nevertheless, for many reasons his conception can be regarded merely as a brillant programme, which could not be carried out within the limits of contemporary science. His activity as regards the development of the partial disciplines of physical geography was more fruitful, chiefly owing to his acute interest in nature observation and analytical investigation.

The fact that the causal correlations of physical geography cannot be investigated in themselves but only in their areal bearings, was recognized as late as the end of the last century as a result of criticism and reaction against Richthofen's general geographical conception. Supan, and later Richter and Löffler, emphasized that a proper knowledge of landscape was the very marrow of geography. Its importance was advocated by Partsch, Hettner, Passarge, Granö, Berg and Teleki, too.

At the beginning of this century, the dualism that had governed general geography previously was replaced by the landscape-geographical synthesis, mostly distorted by the conception of uniform geography and, in addition, by a geopolitical approach. What is more, the extremists of landscape theory (Granö 1929) went so far as to deny the very existence of general geography.

Of the representatives of the western geography, Passarge was the first to declare that landscapes cannot be regarded as areal units scattered irregularly, for they show a zonal arrangement corresponding to the climatic and vegetation zones. In his landscape geography the climatic and vegetation zones figure as landscape belts which are identical with the geographical zones of Granö. Hettner, however, believes that there is no genetical relationship between zones and landscapes, that a landscape as a spatial product of landscape-forming agents represents a chorological, static concept.

In contrast, some geographers, e.g. recently Markus, maintain that landscapes are dynamic evolutionary complexes.

In Russia the foundations of landscape geography were laid by Dokuchaev who recognized the geographical zones as taxonomic units of the uniform and indivisible geographical mantle. Berg holds that zones are composed of landscapes. This opinion has been shared by a considerable number of

Soviet geographers, too, who emphasize that landscapes are contradictory, dialectic areal units changing from place to place and from time to time.

The more recent representatives (Tansley, Solntzev, Neef, Haase, Troll, Markus, Sukachev) of landscape ecology (Landschaftsökologie in German and landshaftovedenie in the Soviet literature) consider as a fundamental aim the detection of regular interconnections and functional, causal structures of the geofactors composing the landscape complexes (surface, lithology, climate, hydrography, vegetation, soils, etc.). Investigations can be most suitably carried out on surfaces of very small extent, the landscape ecology of which is equivalent at almost every point. These are referred to by Neef as landscape-ecological basic units. Landscape ecology also studies the combination and position of these basic units (ecotopes), and attempts to detect the laws governing them. Investigations by Soviet landscape ecologists are also carried out on small areal units characterized by similar features and relief structure, microclimate, vegetation and soil cover. These small landscape-ecological basic units are termed: epimorph (Abolin), epifacies (Ramensky), facies (Nalivkin and Berg), geomorph (Kanonnikov), microlandshaft (Larin), biogenocoenosis (Sukachev). Corresponding terms of the German literature are Ökotop, Landschaftsteil, Landschaftszelle, Landschaftsform, Standortseinheit, Biochore.

K. G. Raman describes landscape categories of the first, second and third order which are understood as regularly arranged minor areal units and associations of definite landscape-ecological units. The first category includes the facies, the second the series of facies (ryad faciy), podurochishche and urochishche as facies groups, the third denotes the podrayon and rayon.

In the German literature the terms Ökotopgruppe or Ökotopchor are used (Haase 1961) for categories higher than the landscape-ecological basic unit.

In current practice, the highest landscape-ecological categories are the landscape belts, landscape zones which, being climatic and consequently plant, soil, etc. zones of the Earth, are the subjects of landscape research.

Practically no landscape research had been conducted in Hungary up to the second quarter of this century. In fact, P. Teleki had formulated the tasks of complex landscape research, which were accepted, in principle, by the Hungarian geographers, yet no co-operatives could be set to work to study and explore in detail and in a complex manner all the landscape factors in Hungary. Gy. Prinz (1936) presented some landscape analyses which, however, contained only general considerations. In the thirties, a more important work was undertaken by K. Kogutowitz (1930–36), who in his chorographies, covering Transdanubia and the Little Plain, kept to uniform geography and used few analytical data, but relied on rich source material. Concise chorographies on the Great Plain and the Little Plain were issued by B. Bulla (1940, 1941) which, however, were followed by general geographical, mainly geomorphological, investigations up to the fifties.

It was in the past decade that scheduled landscape research started in Hungary, too. Complex monographs were written on the landscapes of the Börzsöny and Mátra Mts (Láng 1955), on the Mezőföld (Ádám, Marosi and Szilárd 1959), and on the Nyírség (Borsy 1961). Further landscape monographs are soon to follow.

The research methods raised many problems in Hungary, as they did in other countries. One, e.g. is due to the fact that several branches became separated from geography to meet practical demands. Thus a series of new disciplines which emerged during the last fifty years are engaged with much more effective methods, means and personnel in studying landscape factors and their laws. Their possibilities are enhanced by planned economy. During the course of development, geographers, as a rule, have not been able to keep all the branches of their science at an up-to-date level. Individual researchers are even less capable of performing complex investigations into landscapes, i.e. of detecting the complex interactions and relationships of the landscape factors in detail. At present, this work is usually undertaken by teams of workers including geomorphologists, climatologists, hydrogeographers, geobotanists and pedologists and possibly other specialists. However, this often results in an encyclopedical treatment which may collect abundant evidence on all landscape factors, but essentially lacks elucidation as to the interrelation of the factors, i.e. geographical synthesis. So, however precious a treatise may be, it hardly can contain really up-to-date evidence on a coherent portion of the earth's surface or even on an objectively existing landscape. The value of its practical utilization will be limited, owing to its encyclopedic nature, and it may be questionable whether it is actually a landscape treatise at all.

Such works, valuable in their own way, have been produced by both Hungarian (e.g. The physical aspect of Budapest) and foreign[3] geographers.

The necessity of establishing an applied branch of landscape geography

It follows from the above that landscape ecology and encyclopedical landscape survey—with all their results and shortcomings—require, like the other geographical disciplines, their applied branch to be established.

Owing to social and economic development, life undergoes a substantial transformation, and this involves a more intense interaction between science, which furthers the progress of economic life, and economy, which sets forth new problems to be solved by science. Accordingly, it is necessary to establish the applied branches of physical geography, including landscape geography. This, however, does not mean that physical geographers should pursue narrow practical aims. Preserving its character as a fundamental discipline, geography virtually will keep on with scientific researches by means of improved techniques, but at the same time its results will serve the economy as directly as ever.

With a view to these facts, we believe that *physiographic landscape evaluation, as a new applied geographical discipline, a new chorographic trend*, will be one of the most important means to meet practical economic demands.

Landscape evaluation is premised on detailed analytical physico-geographical investigations into the landscapes. It assumes moreover the utilization and preservation of the positive results of the earlier encyclopedical researches and landscape ecology. These, together with the practical researches of the cognate sciences, will furnish the foundation of a highly developed landscape synthesis—whether in concluding chapters to traditional chorographic treatises or in independent studies—which will bring into relief the potential of the landscape, i.e. the favourable or unfavourable physical features influencing economy; so this will be the *subject* of landscape evaluation.

Landscape evaluation naturally involves a great number of methodological problems. At the Geographical Conference held in Hungary in 1962 the authors, relying on the results of their own analyses and on those of related sciences—without entering into details—attempted to present a model essay of this kind on the Somogy Hill Country (Marosi and Szilárd 1962). But it was impossible to discuss methodological questions within the scope of that paper. Since, however, landscape evaluation was favourably received by the Hungarian as well as foreign participants in the Conference, it seemed to be reasonable to elucidate the questions of methodology. Therefore, a polemical essay was prepared (Marosi and Szilárd 1963a), the discussion of which resulted in the publication of a paper (Marosi and Szilárd 1963b) on the principles and methods of landscape evaluation.

The categories of landscape evaluation; the concept of ecopottype

The categories of landscape evaluation as an applied geographical discipline having peculiar subject and aim are to be defined somewhat differently from those of the traditional landscape ecology which, in the first place, tends to demonstrate the detailed physiography of the regions. Landscape evaluation expounds and evaluates the physical features from the point of view of their being either advantageous or disadvantageous for the economy.

Considering that landscape evaluation follows, as a rule, the research method of the traditional landscape ecology, in that it deals with distinct landscapes (landscape categories), it also develops from the basic consideration that landscapes are different. For example, some of them are scenes of highly developed industrial production on account of their mineral and energy resources; others for lack of such resources lend themselves to intensive agricultural exploitation; and there are numerous ones representing different extremes or transitions. The division of the territory of Hungary into macro-, meso- and microlandscapes, partly accomplished in the course of traditional chorographic research (Bulla 1962), necessitates further investigations and debates. It may be a subject for debate whether the landscape categories outlined in this way are valid at all. Without tackling details of the question, we can state here that landscapes represent diverse types also from the point of view of their features yielding different economic possibilities, i.e. of their potential, which is the basic point in landscape evaluation. The types have, in turn, different ranks. Each macrolandscape represents a type, e.g. the Great Hungarian Plain and the Little Plain are landscape types offering favourable physical conditions for agricultural production. The Transdanubian Central Mountains and the Central Mountains of North Hungary are fields of "Hungarian power production" owing to their mineral resources. The physical conditions of the Transdanubian Hill Country can be utilized by industry, mining and agriculture, as this landscape shows a heterogeneous and transitional character (see, e.g. the great difference between the Mecsek Mts and the Central Somogy). The same holds true for the Subalpine Region.

Of course, none of the macrolandscape types exhibits a pure pattern for possible uniform economic utilization. More uniform types can be recognized at the mesolandscape level, while completely uniform ones may be found among microlandscapes. This does not imply, however, that a landscape, even a microlandscape, the present physical characteristics of which correspond to the concept of the uniform type (e.g. it is feasible either for agriculture or for sylviculture), may not turn into mixed type by later discovery of mineral deposits; nor does it mean that a landscape that used to be uniform may not become a mixed type in our days. We may refer here to discoveries such als the Zala oil field, the exploitation of which has amplified the physiographical aspect of the landscape, which is splendidly reflected by the subsequent changes in the economic and social life of the region, brought about by exploring and exploiting the resources of nature in a way unknown earlier.

When starting work in landscape evaluation, we must be aware of the fact that each landscape involves specific conditions and belongs to one of the landscape types. Moreover, when differentiating more or less uniform landscape types (e.g. a landscape type with physical conditions for agriculture), we have to typify the individual sectors of the landscape, too, i.e. we have to distinguish those subtypes the particular physical conditions of which offer various economic possibilities within one region.

The types, subtypes and smaller subdivisions of landscape evaluation in most cases correspond to the first, second and third categories of landscape ecology. Divergencies, however, are evident as to the function of the branch of economy chosen as the basis for typology. Such types were distinguished and characterized by the authors in their paper presented at the Geographical Conference of 1962 held in Hungary. Their types distinguished for agriculture (1. alluvial reliefs, 2. blown-sand surfaces, 3. lower-seated loess surfaces with smaller relative altitude, 3. higher-seated loess surfaces with greater relative altitude) differ from each other by their geological structure (lithology), climate, hydrography and soil features and, for this reason, they offer different conditions for agriculture. For lack of a better term, the authors referred to these types as *regions*.

However, we do not think this term adequate to the concept as considered by us. Besides, it has already been used to denote a different concept in geography. The applied branch of landscape ecology, the landscape evaluation, needs a special denotation for its research units, i.e. types and subtypes, which might be termed as "economic-potential types". For the sake of shortness, its abbreviated form: "ecopottype" is proposed. According to the above, ecopottype is not identical with the biotophor group of biotops of landscape ecology, nor with any category of the economic region or with the regional types of the production (although they often coincide geographically), but represents the areal unit types of the physical conditions for economy.

A thorough detection of the conditions may reveal the smallest and already almost homogeneous units of the ecopottype. However, the attribute smallest is not used here with areal connotation, it refers to a unit rank. For example, a homogeneous, completely even solonchak area having an extension of 100 km^2 represents the same rank of ecopottype unit as a blown-sand dune range with an area of a few square meters. As shown by this example, an infinite areal division would, in certain cases, be impractical and frequently unfeasible in the course of investigation. Furthermore, we have to point out that the attribute homogeneous only refers to the homogeneity of physical conditions and not to the homogeneity of economic utilization. This implies that a homogeneous ecopottype of uniform microclimate, chernozem soil and flat surface may be suitable not only for maize growing but also for more varied cultures. In the last resort, it is the economico-political factors that will determine how it should be utilized. Some ecopottypes may be most feasibly utilized by a fairly uniform or entirely homogeneous production (e.g. beech wood on a steep ; dessected edge of northern exposition, liable to erosion and having a deep soil mantle and a colder microclimate abundant in rainfall); but sometimes homogeneity has the very meaning that the respective ecopottype is totally unsuitable for agriculture (e.g. steep slope with sink-holes, barren rocky surfaces, etc.).

Nevertheless, in the practice of landscape evaluation only the extensive, inhomogeneous or complex ecopottypes or their groups are distinguished, i.e. those of the second, third or of even higher degree. The geographer when making landscape evaluation must check whether the homogeneous utilization of the area is adequately justified by economico-political factors, or he has to suggest that the land utilization should be modified according to the conditions of the inhomogeneous or complex ecopottype which vary from spot to spot.

In conclusion, we may state that the main tasks of landscape evaluation are *to distinguish ecopottypes* of particular character and rank and to perform their complex *physiographic characterization* and *economic evaluation*.

It is only in the rarest case that the units of landscape evaluation, i.e. the ecopottypes, cover a continuous area unit coinciding with the individual categories of landscape ecology (with the macro-, meso- and micro-landscapes of the Hungarian nomenclature or with Raman's landscape categories of the first, second and third order). As a rule, they form groups or assemblages of ecopottype "spots" (Marosi and Szilárd 1962), the areal features of which, though determined by physical laws, reflect the accumulating effects of human artefacts and demonstrate the principles and regularities of human activity in transforming nature.

When evaluating landscapes, we have to take care that all these factors should be represented on the map.

Principal aspects of landscape evaluation; the question of physiographic or economic approach

In the course of landscape evaluation the question arises whether to approach the problems from the physiographic or from the economic angle. The physiographic approach requires the analysis of the features inherent in stratigraphy, tectonics, lithology, morphology, climate, hydrography, flora, fauna and soils, and their influence, advantageous or disadvantageous, on the economy of the region. The economic approach consists of a complex evaluation of the region for industry, mining, agriculture, forestry, fish and game breeding, transport and communication, settlement, recreation, tourism, and the significance of the physiographic features for the individual branches of economy (Fig. 1).

At present we are not yet able to size up the advantages or drawbacks of these two working methods. The physical geographer, because of the special interest and nature of his science will most likely give preference to the first, while the second seems to do better service in compiling physiographic evidences for economico-geographical works.

For certain particular landscape types, however, a combination of the two methods may appear to be feasible. This combined method can be used in two different ways:

(a) First we arrange our material according to the traditional succession of the physiographic disciplines and then try to approach a complex evaluation of the physiographic environment, with a view to the practical requirements of the individual branches of economy.

(b) In the case of a suitable landscape type, to avoid repetition, we evaluate the conditions on a comprehensive regional scale (not considering minor subdivisions, ecopottypes, types and subtypes of different physical conditions). For example, in a predominantly agricultural area the tectonics, stratigraphy and geological history may be evaluated with the purpose of revealing economic possibilities for the utilization of mineral deposits, rock varieties, etc., that may occur in the region. In the same way we may evaluate the hydrogeographic features from the physiographic point of view, on a regional scale. In contrast, those physical properties which directly affect the economy of the region are evaluated from the point of view of the prevailing economic branches, i.e. as complex assemblages of the conditions provided for agriculture, transport and communications, etc. In rolling landscapes and plains characterized by agricultural production, it seems highly expedient to give a complex evaluation of the physical properties of each minor subdivision, i.e. of the ecopottypes of different rank—as conditions of rural economy.

Whichever of the two approaches is chosen, a chapter or an essay on landscape evaluation, whether based on encyclopedical physiographic researches including the results of traditional analytic studies, or following the methods and aims of landscape ecology, will present a highly valid and practicable synthesis by a new arrangement of data as regards form, content and genre. Earlier works either neglected the economic evaluation of the researches or gave it secondary importance. Landscape evaluation, however, examines the physiographic environment from the standpoint of practical utilization, and types it by means of a complex evaluation of all the physiographic constituents of the areas. Moreover, it has the advantage that it characterizes each particular ecopottype only once, i.e. if an ecopottype occurs repeatedly in the region, it does not need a second or third description: a sign or symbol indicating it on the map will suffice.

Accordingly, landscape evaluation does not engage in a detailed study of stratigraphy, tectonics, lithology, geological history, geomorphology, cli-

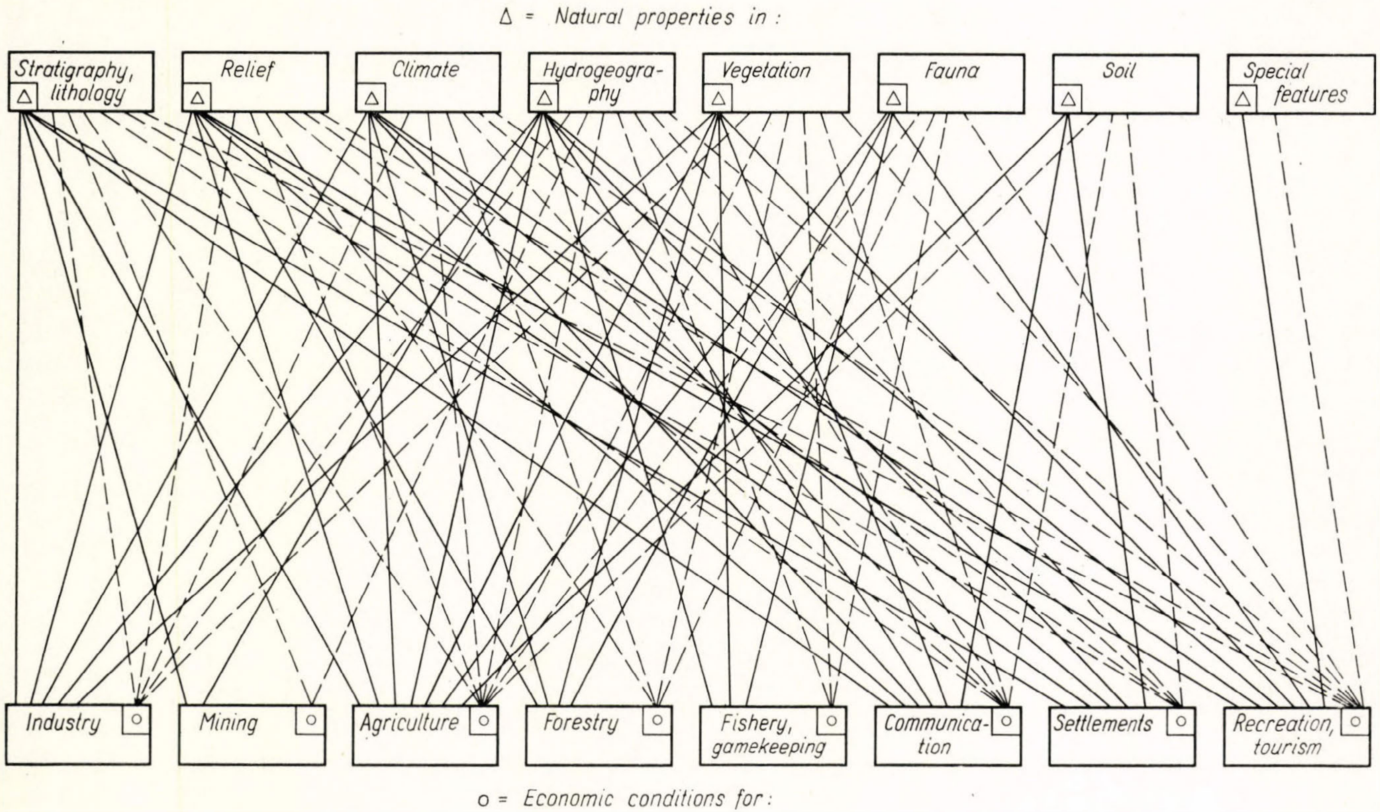

FIG. 1. Different points of approach in landscape evaluation

mate, hydrogeography, vegetation and soil conditions, as that is the task of landscape ecology. The chief aim of landscape evaluation is to detect and evaluate the conditions promoting or hindering human economic activity. In addition, it has to point out the possibilities for a more efficient utilization of the physical properties as ways and means of overcoming the difficulties arising from unfavourable features.

With regard to Fig. 1, to begin with, we must be aware of the fact that it indicates only the direct relations between the physical factors and the economic branches. The Figure, many-sided as it is, would become even more complicated, if it also represented the indirect relations. (For example, in considering the physical conditions of fish and game breeding, the climatic agents have not been represented, because they act mostly through the medium of the hydrogeographic and vegetational factors. Nor have we indicated the characteristics of soils, as conditions of forestry, since they are closely connected with the other physical factors representing a complex assemblage of physical conditions for forestry, etc.).

Furthermore—and this is a rather essential point—our figure indicates only the simple existence of the relationships, but does not show their intensity. Nevertheless, the latter is very important, for it may widely vary from case to case, and even within one and the same region it may depend on:

(1) The physical conditions in relation to the economic branch (e.g., in the Buda Mountains the communication is conditioned by the relief rather than by the climate), or on the effect of the physical conditions on the economic branch under consideration (e.g., in the former area the relief exerts a greater —in a negative sense—effect on agriculture than on industry, etc.).

(2) The intensity of the correlation may also vary according to the characteristics of the regions (e.g., in a region utilized by industry, the partial or complex effect of the physical conditions on economy will greatly differ from those in a region used by agriculture. Of course, the structure of industry and the character of physical conditions may involve additional complications).

(3) The intensity of this correlation is markedly influenced by the stage of social-economic development. Namely, there seems to be a correlation in which the role of the physical features, as conditions of economy, declines in direct proportion to the development of social-economic life, while the reaction of social-economic life on nature increases in direct proportion to this development. This appears partly in the transformation of nature, partly in the best possible utilization of the favourable physical conditions or in the most effective elimination of the unfavourable factors.

Beside the above-cited laws, there are a number of additional ones which hold more or less valid for the intensity of correlations. Without entering into details here, we can state that, for the present, agriculture is the economic branch most emphatically bound by the physical conditions. This is why landscape evaluation has to pay particular attention to the evaluation of the physical conditions of agriculture.

In this line, we have already published some material on the methods of physiographic evaluation of stratigraphic, tectonic, lithologic, geomorphologic and hydrogeographic features. The methods of the complex economic evaluation of the physical conditions of communication and settlement have also been dealt with (Marosi and Szilárd 1963a, b). The methodological principles required for a complex evaluation of additional physical factors, i.e. of those influencing the physical conditions of further possible economic branches are being elaborated. So, in the following pages we shall content ourselves by outlining the methodological principles of the complex evaluation of some model ecopottypes in the agricultural rolling landscapes and plains of Hungary. Some ideas concerning the irrigation problems of almost all ecopottypes of this kind will also be set forth.

Principles of evaluation of some ecopottypes in agricultural areas

In areas of this kind the landscape evaluator has to decide which of the data obtained by analytical investigations and from the cognate researches are the most essential, and which allow the best possible conclusions for motivating and furthering the economic activity (e.g., while evaluating the climate, we have to give preference not to the stereotype graphs of averages, but to the data of the individual climatic factors calculated for the growth period, which also inform about the frequency of the extreme values, and to the relationships between the phytophenological phases and the physical conditions). Of course, the really important data have to be presented in a clear form and possibly in graphs and well-constructed map-schemes, in order to substantiate and complete the text.

In the course of this work the first task is to divide the landscape investigated into ecopottypes, according to the conditions offered for agriculture. The individual physiographic factors are determinative of the differentiation of ecopottypes. Nevertheless, one of the factors—in most cases the relief—may influence the behaviour of the other physiographic factors to such a great extent as to determine, through them and together with them, the character of the whole ecopottype. Within a mesolandscape the climate usually does not show a varied typology, being controlled by the laws of zonality. This, however, does not mean that no essential differences can be found in the local and mesoclimates of the individual ecopottypes within one and the same mesolandscape. Such differences are, in general, motivated by relief varieties. They are reflected by the natural plant cover as well as by the soil, i.e. the proper basis of agriculture. Lithology also plays an important role in the determination of the character of ecopottypes, in part directly, in part through its effect on the water regime, the relief and the soil formation.

(1) The landscape evaluator may differentiate, as independent ecopottypes, the low-seated alluvial surfaces which are usually flat or exhibit but negligible level differences. Anyway, it is just these slight level differences of the alluvial surfaces that are often responsible for the divergences in soil conditions, drainage, or even in the entire water regime of the individual surface portions; they sometimes affect the microclimatic conditions, which may, in turn, show marked contrasts as to the possibilities of their economic utilization. By these level differences the evaluator may be induced to distinguish special

sub-ecopottypes, too. Deep, ill-drained sections frequented by floods and slack waters will favour peculiar vegetation, the decomposition products of which, under special circumstances, may bring about formations of bog soils, peaty earth or peat, which can be made subject to tillage only by means of melioration. The physical geographer, relying, of course, on the results of investigations of other fields, too, has to make thorough investigations as to which parts of such areas deserve melioration investments, or whether the elimination of the harmful factors is for the moment feasible. He has to point out the methods of drainage, pasture and grassland farming, rice growing or fish breeding. The possible interrelation of the water regime and alkalization always deserves a special attention.

A sub-ecopottype of a fairly high alluvial level, where water cannot represent a dangerous, disadvantageous factor but rather appears as groundwater situated at a proper level, occasionally may stand a chance of intensive plant growing (horticulture), too. In such cases, first the physical conditions which promote or impede utilization have to be taken into consideration, then the climatic conditions, with view to the climatic requirements of the plants to be grown there. Special attention should be paid to the averages at growth periods and to the frequency of extreme values (e.g. risk of frost). Considerable differences may arise from the lithological composition of the drainage area of a stream (or lake), the alluvial deposits of which greatly influence the soil conditions. In a word, the physical and climatic factors must be evaluated always in their real, complex correlations and interactions.

(2) In Hungary the sand areas commonly adjacent to talus fans or terrace surfaces are characterized by physical conditions different from those of the alluvial surfaces. During the Pleistocene and the Holocene they had already got rid of the activity of streams. Climatic conditions, loose rock material and particular water regime are responsible for the transformation of these areas to blown-sand landscapes, as a result of deflation. This explains their peculiar surface form, too. However, the blown-sand landscapes of Hungary are not completely uniform, they differ from one another in relief and soil conditions. Neither their macroclimate nor their lithology are uniform, owing to the different drainage basins of the streams which deposited the alluvium. All these and some additional factors are responsible for the fact that, e.g., the calcareous blown-sand surfaces in the Danube—Tisza Midregion have properties altogether different from those of the acid-sand areas of the Nyírség or Central Somogy. Nevertheless, they have numerous common features (e.g. similar water- and heat-economy).

The sand surfaces of a mesolandscape usually represent one ecopottype, which however, can be divided into several sub-ecopottypes. Such are the surfaces bound and planated by tillage work of centuries, in contrast to sand areas subjected to more recent sand movement, and having consequently a more marked relief or being less covered by soils, if not completely loose. If it is possible and reasonable to bind them, it has also to be referred to. Nota bene, the positive features offer possibilities other than the depressions and low grounds of the same sand surface. Their groundwaters, insolation and heat-economy may show a great variety even within a relatively small area, and so do the features and thicknesses of their soils — a consideration usually neglected by agriculturists. It is as much a commonplace to speak of sandy-soil farming, and of sandy-soil cultures, as it is to characterize a particular plant by stating that it can be grown on sandy soils, too. However, no detailed survey of these small sand surface "spots" has been undertaken as yet, maybe because the sandy-soil cultures are relatively fresh, and the mere fact that the sand surfaces could be put to tillage has been considered to be great progress. Therefore, it is our task to detect the soil conditions and the climatic features of the peculiar sand surfaces by means of special investigation. So, in addition to a general landscape analysis, we shall be able to give the rural economist an analytical evaluation, too. Perhaps this is the very domain where our recommendations, exceeding the scope of geographical survey, may be very important for the people's economy. The taking up of some of the agronomist's duties would, of course, require much experience and, above all, a well-grounded pedological knowledge. Lacking these, the landscape evaluator still may be able to check to what extent the principal cultures got acclimatized to the physical conditions offered by the sandy relief. This work may throw light on farming misuse of the physical conditions, or reveal new interrelation, provided the landscape evaluator is acquainted with the claims of the plants. Then his propositions will promote the propagation of the potential intensive cultures (vineyard, orchard, etc.).

(3) The loess and its varieties as sediments representing the mother rock of some soils may be determinative of a special ecopottype. Besides the common mother rock, however, the relief, the relative altitude, may also play the role of an independent determinative factor. E.g., in the course of the landscape evaluation of the Somogy Hill Country (Marosi and Szilárd 1962) the authors had to separate the lower-seated loess platforms of smaller relative altitude (local height below 180—200 m a. s. l., relative altitude less than 50 m/km^2) from the higher-seated (above 180—200 m a. s. l.), tectonically more disturbed loess surfaces which have been more intensively dissected by the external agents and have a more considerable relative altitude. As a matter of fact, the former provide capital possibilities for agricultural production, while the latter can be utilized in many cases by sylviculture only.

The high-quality soils of the lower-seated loess surfaces and their generally favourable climate permit the growing of a great variety of crops. The various climatic conditions, naturally, produce varied soils on loesses, too. Where the atmospheric precipitations are somewhat more abundant and the mean annual temperature is a little lower, than in neighbouring regions, more compact loamy soils are formed. Their chemical composition differs from that of other soils in the environment, and this is more than enough to disturb the optimum conditions for the plant to be grown on them. Highly calcareous, crumbling chernozem soils formed in the most characteristic loess areas under appropriate climatic conditions are most suitable for growing plants requiring much lime. These soils also have the best properties as regards retention of soil moisture. They enable even the hoed plants requiring long growth time and much soil moisture to survive drought periods, without irrigation.

Considerations like these are to determine whether the production is in optimum accord with the physical conditions. To protect first class soils is naturally a primary task. We have to pay attention to the dangers that may arise from deterioration of cloddy structure, from formation of a compact soil layer, from the presence of layers of calcareous concretion, and from the erosional destruction. This last endangers only small surfaces in these areas, and even them less seriously, than the more dissected, higher-seated loess surfaces. Nevertheless, it is indispensable to size up its effects and to make suggestions as to the possible measures to be taken against them.

The questions of soil destruction in these areas, and practically on all the slopes subjected to tillage, are closely interrelated with those of the development of slopes and with the questions of their practical utilization. In fact, the slopes have to be evaluated not only according to their exposition, insolation and gradient (a factor determining cultivation, especially mechanical tillage) but also with regard to the quantity and quality of rock varieties redeposited on the slopes and to the degree of their denudation. In this connection, we have to make use of the practical bearings of M. Pécsi's (1962) most recent investigations into slope morphology. According to Pécsi we should figure with much larger amounts of redeposited sediments than commonly thought of so far. These slope sediments usually consist of a specifically stratified mixture of rocks, the sources of which have lain above the current inflexion zones of the slopes. Various fossil soil remnants of stratified arrangement abound in such deposits. It is important to make a qualitative and quantitative analysis of the slope sediments redeposited by solifluction and corrasion, as they can yield the plants more nutrients than the raw mother rock itself. This holds true chiefly of such areas where soil erosion, due to human activity, removed the fertile soil but exposed slope sediments containing fossil soil remnants, which in the periglacial period had a different position above a different inflexion zone. Such sediments as, e.g., the "kovárvány" (red-banded sandy soil) layers in sand areas, provide rather good possibilities for agriculture. This explains why raw slope loess offers better conditions for plant growing than other rock varieties do.

We have to evaluate, besides the particular water economy of loesses, also the climatic factors in loess areas in the same way, i. e. always with view to plants which can be grown under optimum conditions.

(4) Higher, more dissected loess areas raise many problems similar to those of the former ecopottype. In addition, special attention is to be paid to the much more intensive soil erosion, to the deep position of the groundwater table and to the problems of their accessibility for mechanical tillage. In the first place it is here that we have to reckon with steep-walled ravines rapidly downcutting backwards, with ramifying valley heads, with valley sides and edges exhibiting landslides, collapses, downfalls. The possibilities offered by these areas for agricultural plant growing are rather limited, although their ecopottypes may show very heterogeneous composition. Here again it is one of our most important tasks *to distinguish sub-ecopottypes*, no matter how small and scattered surface portions they may consist of. It is altogether obvious that a relatively flat or gently sloping ridge top- or ledge-surface which is exposed mostly to the south is preferable to a steep-valley edge of northward exposition. Instead of suggesting agricultural utilization of surfaces covered by forests, we may often propose the contrary, i.e. to preserve the forest, and what is more, to enlarge its area. It is commonly known that

improper fellings will cause thorough destruction to the soil, further relief fragmentation, and, consequently, a material expansion of soil erosion.

Owing to a high elevation a. s. l. or to a particular relief, the extremes of mesoclimatic conditions may restrict the possibilities for growing several plant cultures even if soils are adequate anyway. So to study and detect the local peculiarities of the climate is also indispensable when making plans for crops to be grown in areas like these. However, evidences available for the landscape evaluator in this respect are rather scarce. For lack of concrete measurement data concerning local- and microclimate (our research work rarely allows to obtain serial measurements for a longer period) we can only rely on conclusions drawn from the vegetable life. And this holds true not only for this case but for landscape evaluation in general. By observing the vegetation we can shed light upon local peculiarities in climatic and soil conditions alike.

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Special attention must be paid to the practical problems of *irrigation* in almost all the ecopottypes utilized for agriculture. To develop an agricultural production as intensive as possible, is a target that must always be kept to when considering the possibilities and requirements of irrigation. First of all, we have to estimate the possible amount of waters available for irrigation from streams, reservoirs or subsurface waters; the quality of the waters (chemical composition in terms of pedology); the investments needed for irrigation. Then we have to measure up the possibility of conducting water directly from surface-water streams, or the necessity of constructing reservoir basins. The latter case assumes that the measurements of stream yield give favourable results, and the morphological and stratigraphical conditions are also adequate. The same principles are valid for sizing up the areas to be irrigated. Of course, the problems of irrigation are more pressing in drought-stricken areas. Where the precipitations are different, or show an irregular distribution, it is very important to consider all possible means, since even the rather costly irrigation plants may prove to be remunerative, if drought is the main obstacle to plant growing. Irrigation plants can be recommended in areas abounding in water for irrigation, though relatively poor in rainfall for the watering of any plants that can grow fairly well by meteoric waters but which, if watered, yield a crop value exceeding the costs of irrigation. Thus the economy computations—though performed not by the physical geographer—have to be taken into consideration in every case. If the yield of some highly profitable cultures of long growth period (fruits and vines or vegetables, fodder crops and hoed plants) can be somewhat increased by means of irrigation, even a slight increase will refund the investment costs sooner than would a seemingly higher increase by non-intensive cultures.

Many additional standpoints may combine in the analysis of the possibilities of irrigation and of lucrativeness. For example, the favourable market or transport conditions may justify the irrigation of some intensive cultures even when other plants would grow without irrigation. In Hungary, ample literature is devoted to the extremely varied problems of irrigation, including numerous physical and economic questions. This also advocates its discussion within the scope of landscape evaluation.

In conclusion, we wish to stress again that we could by no means hope to achieve completeness in our paper. As has been shown, the problems are extremely complicated, not only due to the close relations and interactions of the physiographic agents but also to the interrelations of economic geography and cognate sciences.

During landscape evaluation in further model areas (plains, mountains, etc.) there may arise new ideas which contribute to the solution of the numerous questions as yet unsettled. Furthermore, it is desirable to approach the evaluation of the physical conditions from the viewpoint of the individual branches of economy (industry, settlement, communications, etc.) in collaboration with the specialists of economic geography. Our present paper is only an attempt to start the work which, in our opinion, will direct the physical geographers to one of the ways to be followed in a boundary zone of many disciplines, where the convergences are yet unknown, and even less known are the short cuts to the main road which leads to the goal of satisfying the demands of economy.

Bibliography

ÁDÁM, L., MAROSI, S., SZILÁRD, J. (1959) A Mezőföld természeti földrajza (Physical geography of the Mezőföld), *FM*, vol. II, 514

ASZTALOS, I. (1961) Vita a természeti és gazdasági földrajz kapcsolatáról (Discussion on the relationship of physical and economic geography), *FÉ*, vol. X, 252—7

BARISS, M. (1956) Természeti földrajz és építési előtervezés (Physical geography and preliminary building project), *FÉ*, vol. V, 11—20

BERG, L. S. (1950) A földrajzi tájak (Geographical regions), *FKTÉ*, vol. I—III

BERG, L. S. (1958) Die geographischen Zonen der Sowjetunion, Leipzig

BILLWITZ, K. (1963) Die sowjetische Landschaftsökologie, *Petermanns, Geogr. Mitt.*

BORSY, Z., (1960) A Nyírség természeti földrajza (Physical geography of the Nyírség), *FM*, vol. V, 227

BULLA, B. (1940) Az Alföld (The great Hungarian Plain), *MSzKt*, vol. 116. 79

BULLA, B. (1941) A nyugati országrészek (The western regions of Hungary), *MSzKt*, vol. 117, 80

BULLA, B. (1954) Az elmélet és a gyakorlat egységének kérdése és a hazai geomorfológiai vizsgálatok (The question of unity of theory and practice with respect to the geomorphological investigations in Hungary), *FK*, vol. LXXVIII, 181—9

BULLA, B. (1962) Magyarország természeti tájai (The landscapes of Hungary), *FK*, vol. LXXXVI, 1—16

ELEK, L. (1956) A gyümölcstermő tájak és tájoptimumok kutatása (Research of fruit-growing regions and optimum landscapes), *FÉ*, vol. V, 299—324

(DOKUCHAEV) Докучаев В. В. (1948) Учение о зонах природы. Москва

GRANÖ, L. G. (1929) Reine Geographie, Helsinki, *Acta Geogr.* no 2

GYENES, L. (1961) A magyarországi termőtájkutató munkák földrajzi tanulságai (Geographical results of the investigations into fertile landscapes of Hungary), *FÉ*, vol. X, 39—111

HAASE, G. (1961) Landschaftsökologische Untersuchungen im Nordwest-Lausitzer Berg- und Hügelland, Leipzig Univ.

HETTNER, A. (1927) Die Geographie: ihre Geschichte, ihr Wesen, ihre Methoden, Breslau

HUMBOLDT, A. V. (1845) Kosmos, Stuttgart—Tübingen, Cotta

(ISACHENKO) Исаченко А. Г. (1957) Развитие ландшафтоведения в СССР за 40 лет. *Изв. ВГО*, вып. 4

JAMES, P. E., JONES, C. F. (1954) American Geography, Inventory and Prospect, *Syracuse Univ. Pr.*, no XII, 590

KÁDÁR, L. (1941) A magyar nép tájszemlélete és Magyarország tájnevei (The Hungarian people's approach to landscapes and the nomenclature of the Hungarian landscapes), Orsz. Táj- és Népkutató Int.

(Kanonnikov) Канонников А. М. (1957) О терминах «фация» и «геоформа». Изв. ВГО, вып. 2

Kogutowitz, K. (1930—36) A Dunántúl és a Kisalföld írásban és képben (Transdanubia and the Little Plain in words and pictures), Szeged, Egyetemi Földrajzi Int.

Láng, S. (1955) A Mátra és a Börzsöny természeti földrajza (Physiography of the Mátra and Börzsöny Mts), *FM*, vol. I. 508

(Larin) Ларин И. В., Растительность, почвы и сельскохозяйственная оценка Чизинских разливов. *Мат. Особ. ком. АН СССР по иссл. союзн. и автон. респ.* № 2, Серия «Казахстан»

Markos, Gy. (1952) A természeti földrajzi környezet hatása különböző társadalmi formák között (The prevalence of physiographical environment in different social forms), *FÉ*, vol. I, 271—87

Markos, Gy. (1962) Magyarország gazdasági földrajza (Economic geography of Hungary), Közgazd. és Jogi Kiadó, Budapest, 581

Markus, W. (1951) Zur Entwicklung der Landschaft um Schönewerd, *Geogr. Helvetica*, Bern, no 2

Marosi, S., Szilárd, J. (1962) Physisch-geographische Bedingungen des Wirtschaftslebens im Somogyer Hügelland, Budapest, *MFK*, vol. I

Marosi, S., Szilárd, J. (1963a) A természeti földrajzi tájértékelés módszertani kérdései különös tekintettel dombsági tájak értékelésére (Methodological questions of physiographic landscape evaluation, with special regard to the evaluation of rolling landscapes), *MTA FKCsEMV*, vol. I, 1—20

Marosi, S., Szilárd, J. (1963b) A természeti földrajzi tájértékelés elvi-módszertani kérdéseiről (On the principles and methods of physiographic landscape evaluation), *FÉ*, vol. XII, 393—417

Mészáros, I. (1961) A természeti földrajz néhány elméleti és gyakorlati problémájáról (Some theoretical and practical problems of physical geography), *FÉ*, vol. X, 239—252

Neef, E., Schmidt, G., Lauckner, M. (1961) Landschaftsökologische Untersuchungen an verschiedenen Physiotypen in Nordwestsachsen. *Abh. d. Sächs. Akad. d. Wiss.* Math. nat. Klasse 47/1, Leipzig

Passarge, S. (1919) Die Grundlagen der Landschaftskunde, Hamburg, Hansa Verlag

Pécsi, M. (1962) A magyarországi pleisztocénkori lejtős üledékek és kialakulásuk (Pleistocene slope deposits of Hungary and their formation), *FÉ*, vol. XI, 19—39

Pécsi, M., Sárfalvi, B. (1960) Magyarország földrajza (The geography of Hungary), Akadémiai Kiadó, Budapest, 327

Pécsi, M., Marosi, S., Szilárd, J. (1958) Budapest természeti képe (The physical features of Budapest), Akadémiai Kiadó, Budapest, 744

Prinz, Gy. (1936) Magyarország tájrajza, I. rész (The topography of Hungary, Part I; in *Magyar földrajz*, Budapest, 341

(Prokaev) Прокаев В. И. (1961) Фация как основная и наименьшая единица ландшафтоведения. Тексты докладов. *Материалы к 5 Всесоюзн. совешаниям по вопросам ландшафтоведения.* Москва.

(Raman) Раман К. Г. (1959) Опыт классификации и типизации географических ландшафтов как основа для физико-географического районирования. *Ученые записки Латв. Гос.Ун-та им. П. Стучки.* т. XXII, II, № 2

(Ramenskiy) Раменский Л. Г. (1938) Введение в комплексное почвенное и геоботаническое изучение земель. Москва.

Szabó, P. Z. (1953) A természeti földrajz a szocializmus építésének eszköze (Physical geography as a means to the building of socialism), *FK*, vol. LXXVII, 79—99

Szabó, P. Z. (1963) Elnöki megnyitó a Magyar Földrajzi Társaság 86. közgyűlésén (President's address at the 86th gen. meeting of the Hung. Geogr. Soc.), *FK*, vol. LXXXVII

(Solntsev) Солнцев Н. А., Некоторые дополнения и уточнения в вопросе о морфологии ландшафта. *Вестник МГУ.* Серия 5, № 3

Teleki, P. (1917) A földrajzi gondolat története (History of the geographical conception), Budapest, 231

Troll, C. (1950) Die geographische Landschaft und ihre Erforschung. Studium Generale

Wagner, R. (1956) A táj fogalma (On the notion of landscape), *FK*, vol. LXXIX, 335—54

GEOGRAPHICAL FACTORS OF THE FORMATION OF ALKALI SOILS (SZIKSOILS) IN HUNGARY

by SÁNDOR SOMOGYI

Zonal, azonal and intrazonal soils of Hungary

As regards geographical position, the Middle Danube Basin represents a continuation of the brown forest and chernozem soils of the Russian sylvan steppes. It follows from its basin character that the chernozem soil types are confined to its inner area, while in the marginal areas they are followed by the equivalents of the brown forest soils bordering the Russian sylvan steppes towards the north. Since the sylvan steppes of the inner areas have lost most of their natural forests, owing mainly to a longtime agricultural utilization of the land, the brown forest soils here have also evolved a cher-

FIG. 1. Boundaries between the chernozem and forest soils of Hungary (P. Stefanovits 1956)

nozem (A—C Section) structure. Stefanovits regards, with good reason, the semi-humid sylvan steppe as the realm of chernozem soils. Opposing Treitz, Stefanovits (Fig. 1) contracted Treitz's "grassy forest" region on the Great Plain with the chernozem soils, and that in Transdanubia with the forest soils. He drew the boundary on the basis of a 65% air moisture in July (Fig. 2), a figure below which, in his opinion, no closed forest and consequently no forest soil can be formed. (Stefanovits, 1956; Treitz 1913.)

The above spread of the various soils is valid for the present day only. In older times, e.g. during the Holocene, the interaction of soil-forming agents brought about significant changes in the range of the soils. The development of the two soil types mentioned, the alternations of which may be looked upon as climazonal phenomena, has been disturbed by the appearance of a third soil type, notably by the spread of the *intrazonal alkali* *soils (sziksoils)*.* Sziksoils are intrazonal, because they emerge only in the southern margins of the sylvan steppes, or more characteristically in the real steppes throughout our globe. (In this respect, they are to be distinguished from the salty soils, which also are intrazonal but occur in deserts and semi-desertic drainless areas only, as well as from the coastal alkaline salty earths which show an azonal arrangement.)

The spread of the soil in the Middle Danube Basin suggests that the hydrogeographic agents may have influenced, first of all, the formation of the chernozem and sziksoils. In this paper, our primary aim is to trace the spread

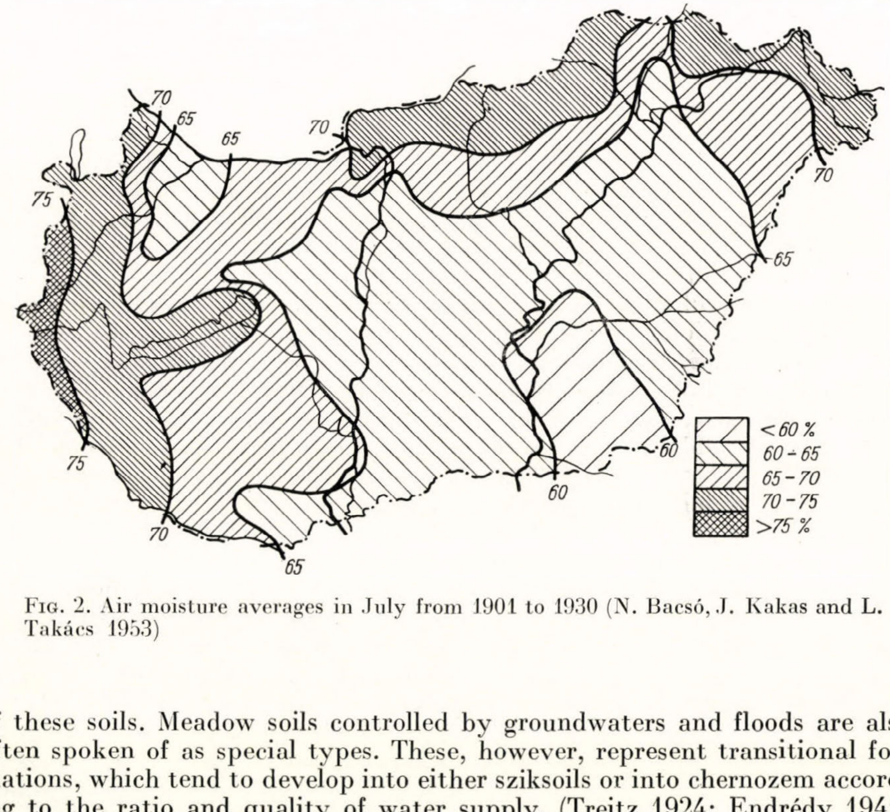


FIG. 2. Air moisture averages in July from 1901 to 1930 (N. Bacsó, J. Kakas and L. Takács 1953)

of these soils. Meadow soils controlled by groundwaters and floods are also often spoken of as special types. These, however, represent transitional formations, which tend to develop into either sziksoils or into chernozem according to the ratio and quality of water supply. (Treitz 1924; Endrédy 1941; Stefanovits 1956.) Since in chernozem soils the absorption process is controlled by calcium, while in sziksoils it is by sodium or magnesium, therefore the hydrogen dominating the cations of meadow soils is replaced either by calcium or by sodium according to the line of development (Endrédy 1941). Consequently, the meadow soils are resultants of local conditions, and as such, they are also azonal (Fekete 1958).

* Sziksoil is the term to denote intrazonal alkali soil in the rest of the paper.

The age of the soil types in Hungary

The Danube is a draining agent, and its flood-plain soils are especially young formations. They do not appear to be older than their mother rocks. Since, however, the mother rocks, as well as the eolian and fluviatile sediments, kept on being deposited as late as Last Glaciation, the soil remnants of Würm Glaciation can by no means be held to be relicts of large extension. Logically, such formations would be expected to occur above the boundary horizon of loesses only (about 400 to 450 m above the Adriatic Sea level), but even there they were demolished by periglacial denudation and solifluction. Still less is the possibility for exposing such "old" soils in the flood plains, which, being mostly subsiding surfaces, were filled up by thick, raw sediments before and during the Holocene. Milkov holds that the soil horizons buried in the valley rivers of the Russian Platform cannot be taken for relicts of earlier climatic conditions. In Hungary such disputable "index" profiles of buried soils have been found by Stefanovits along the Szamos, by Szűcs and Láng along the Tisza, but those soils, too, may date at best from the Late Holocene. It follows from the above considerations that the soils of Würm Glaciation must have originally been skeletal soils, and the soils showing the periglacial forms of silted-up valleys could not be formed during glaciations, but in interglacial phases (Stefanovits 1956).

In the pauses of dust fall and loess formation—these periods without eolian accumulation are indicated by the expansion of forest vegetation—soil profiles of various thickness, like those discovered by Stefanovits and his collaborators at Paks, may have been formed on the Great Plain, too.

During the existence of the taiga-like closed forests of the pine-birch phase, the forest soils and the bogs are likely to have come into prominence. The wide spread of the latter is evidenced not only by the fact that the climate became more humid but also by the marginal subsidences that took place at that time. As no considerable amount of eolian dust has been deposited since, and no gravitational slope movements of sediment masses (solifluction, tundra formations on slopes) have caused any material destruction in the surface, the soils of the low-seated surfaces must have survived from that time on. Except the more recent subsidences, all the soils of terraces IIa that have escaped inundations and superposition of later fresh alluvium — owing to incisions by the rivers and to downcuttings of the terraces—can be ranked among these old soil formations. On the Great Plain this category is represented by the soils covering Pleistocene sands and infusion loesses. The forerunners of the present chernozem soils of Hungary may have begun to form on infusion loesses.

In fact, the extreme climate of the boreal hazel-nut phase was an impediment to the formation of a coherent forest cover, i.e. to that of forest soils of zonal arrangement. This climate has been defined as characteristic of the last climatic steppe period. Hence, the trend of soil formation is shown by the name itself. It was in that period that the climate and vegetation offered most favourable conditions for the formation of climazonal chernozems in the lowlands of Hungary, partly because the evaporation exceeded the precipitation, and partly because the anaerobic decomposition of grassy vegetation, predominant in the previous period on the wide flood plains and loesses, resulted in the accumulation of great quantities of humus. Furthermore, cold winters hampered its too rapid decomposition. The neighbouring vast areas of the flood plains of rivers were covered by azonal varieties of meadow soils, but the formation of the *sziksoils*, a most specific soil type in Hungary, also started at the same time.

The problem of alkalization in Hungary

Since of all the soil types in Hungary it is in the formation of the alkali ones in which the local influences of physiographic conditions, including the water regime, play the most prominent role, and since it is in the water regime of these soils in which human activity has produced considerable changes, we consider it necessary to analyse in detail the geographical conditions of their formation. Of course, we do not mean here to discuss the chemical processes of alkalization, as they belong to the domain of pedology; we are concerned only with such conditions as may promote and control these processes.

An earlier misinterpretation of the doctrines of Viliams gave rise to the conception that alkalization was the result of an inevitable process due to a high absolute age of the soil, in other words, it was a "death of the soil" Later on, however, Ballenegger and K. Páter and more recently Szabolcs (in the 1958 edition of "Pedology" by Fekete) reviewing and explicating the true essence of the same doctrines, have shown that alkalization is rather a sort of soil disease resulting from the physiographic conditions of the region.

Sziksoils have been studied by quite a number of outstanding Hungarian geographers and pedologists, which goes to show how important the scientific bearings of the problem are. Its practical interest lies in the fact that nearly 10% (563,730 hectares according to Stefanovits 1952, p. 311) of the arable area of Hungary suffers from this disease, which means a material loss in crops in spite of extra labour and costs. Owing to the researches of these capable experts, "there is nothing that might be undetected in the problems of sziksoils, only a synthesis is needed". Since the date of this statement by Endrédy which now appears to have been somewhat premature, two important syntheses have attempted to give a pedological explanation of the problem of sziksoils: one by Sándor Arany (1956) covering all the involved regions of Hungary, and the other by Szabolcs restricted to the Trans-Tisza Region. Both authors treated the subject of sziksoils with success, and so did Stefanovits (1956) in a treatise on the soils of Hungary. It is to be regretted only that no *physiographic synthesis* along the line of these investigations has been undertaken as yet, apart from an initial attempt by A. Nagy and E. Korpás (1956). In fact, no partial researches have been undertaken since the initiative of Strömpl. Of course, we are not here trying to fill these gaps. The present paper is confined to giving a geographical, mainly hydrogeographical review of the recent and earlier investigations into sziksoils.

Already Treitz has pointed out (1913), and Z. Fekete has set forth more comprehensively, that the sziksoils in Hungary were formed at a higher latitude, under more humid climatic conditions, and on soils of later origin than, say, in Russia. Szabolcs (1961) recently pointed out that alkaline formations strongly resembling those in Hungary were formed in the Soviet Union, in the woody-boggy region of the Baraba Plain of Western Siberia (between Omsk and Novosibirsk), i.e. in areas situated much farther to the north than Hungary. Since it is only in the steppes that sziksoils can be regarded as intrazonal formations, in the above-mentioned area they may already be taken for extrazonal ones. The reasons for this phenomenon are given in the physical conditions of the area. Namely, no zone of deciduous forests is to be found between the taiga and the steppe in Western Siberia. Hence the Baraba Plain as a sylvan steppe represents a transition zone between steppe and taiga. However, it has, as a whole, a more northern position than the European sylvan steppe, therefore its climate and water conditions are likewise different (Szabolcs 1961).

The agents of alkalization

Salt accumulation. The main cause of alkalization, i.e. the accumulation of alkali salts, chiefly sodium, in the soil profile was detected by S. Tessedik, who was first to describe sziksoils; but no common agreement as regards the mechanism of the accumulation has been reached as yet. Due to the various possible origins of alkali salts, their accumulation cannot be ascribed to a single agent.

The primary source—and in Hungary perhaps the most important one—of the alkalizing salts is, in our opinion, the Tertiary volcanic range bordering the Great Plain. The role of these formations was first recognized by J. Szabó, who emphasized in several papers that soda feldspars originate from eruptive rocks. For example, the sziksoils along Brook Laskó in County Heves were markedly held by him to be the "finest" mud of rhyolite tuff. This explanation was accepted by Inkey and other researchers, although they recorded other sources of salts as well.

The chemical analyses performed by S. Vitális on samples from Salgótarján and Kisterenye proved that it is the high soda content of decomposing rhyolite tuff that plays a decisive role in the process of alkalization. However, not only rhyolites but also andesites may have a high sodium content. This has been further supported by K. Sztrókay's analyses (1936) of ash materials produced by the eruption of the group volcanoes Descabezado in Chile in 1929. The high plagioclase (soda lime feldspar) content of the eruptiva also permits similar conclusions to be drawn (Fekete 1958). Obviously, these latter studies induced L. Kreybig and Endrédy to refer to volcanic rocks as the principal source of alkalizing salts. Endrédy also pointed out that in the Little Plain, where because of the lack of marginal volcanic range no continuous and intensive supply of sodium can be spoken of, no widespread sziksoils can be found. In the Lake Fertő region sziksoils containing Na_2SO_4 are known to occur, while those in the Sárvíz Valley generally contain $MgCO_3$, and are so-called "atkas", for the occurence of which inner conditions are responsible. The latter type is encountered in the Danube—Tisza Midregion, too.

Recently, it also came to light that it is not only the decomposition products of volcanic ash materials that were redeposited—chiefly by fluvial mechanism — on the Great Plain, but also the volcanic rocks themselves, either in form of tuff ejectamenta transferred by volcanic eruptions, or more often by eolian denudation and accumulation during the Pleistocene epoch. Investigations by M. Faragó show that in the loesses about Nagykőrös the feldspar content, including quartz, amounts to 66 per cent. The accumulation of the salt content of loesses is dated also by Soó from the Pleistocene. Of the clay minerals of loess, the bulk of which derives from the marginal mountain ranges, it is the montmorillonite that is predominantly liable to alkalization, as "the Na, due to its proper size, can most advantageously enter its lattice" (a report by Sarkady and Stegena in 1943; comments of Horusitzky, Földváry, Scherf and Vitális; Fekete 1958, p. 22). The study of the "Great Plain loesses" by Széky-Fux and Szepessi (1959) has contributed valuable data to solve this problem. (See, in addition, Sümeghy 1937; Fekete 1958.)

J. Kvassay regarded the salt deposits in the Miocene sediments of the Carpathian Basin as additional sources of alkalizing salts (1876). This explanation was soon flatly rejected. First Inkey and later on Treitz were the only workers who did not exclude this possibility. Recently, F. Szentes called attention to the existence of saline springs of such origin. Chemical analyses of the loads of rivers also show that waters springing from salty areas, such as the Tisza and especially the Maros, always contain Cl ions, and the latter has NaCl in addition. Accordingly, under proper conditions, e.g. in the Hortobágy Region, detrimental salts can accumulate in this way, too.

Galgóczy, refuting Kvassay, suggests that alkaline salts are simply derivates of marine sediments concentrated by evaporation. In the Caspian reaches of the Volga this is really the prevalent type of salt accumulation. According to the data of V. A. Kovda, about 3.5 million tons of salt per year rise from the old marine deposits and disperse over the surface. The case is different in Hungary, since the saline marine sediments, in general, lie at great depths. The salty earths along the River Ural (Volga Region) do differ from the sziksoils of Hungary by the composition of their salts. (Chiefly chlorides occur in the former region.)

Nevertheless, natural springs rising from the depth of the marine beds, as well as artificial artesian and oil drillings reaching down to these sediments, may bring the "latent" salt waters up to the surface. The problems of salt concentration and its possible harmful effects as regards drilling have been dealt with by L. Kreybig, Pávay-Vajna, G. Szurovy, and recently by A. Nagy. Endrédy and Szádeczky-Kardoss unanimously stated that Pliocene sediments contain chiefly $NaHCO_3$, while Miocene beds rather abound in NaCl. So waters obtained from these sections have to be considered accordingly.

Considering the above, Treitz appears to have been right in suggesting that the salts of deep-seated marine sediments come up as gases exhalated along the fracture lines reaching up to the surface. Treitz's suggestion, however, had hardly any influence on the rather vivid debate on the problems of alkalization. K. Papp did not altogether omit the probability of such an interpretation, but Scherf (1928) totally rejected it, emphasizing that the alkalized flat surfaces are situated along the fracture lines just because they were formed in beds of palaeostreams which could adjust themselves to the directions of the fracture lines. Sigmond and Endrédy also opposed to Treitz's hypothesis without having studied it according to its merit. Nevertheless, there have come more and more evidence to prove that the waters ascending along fracture lines have a salt content much higher than those brought up by drilling at other places. Finally, it was Scherf himself then Stegena and Szebényi who, by investigations into the surroundings of Tiszagyulaháza and the Danube—Tisza Midregion, proved that the fracture lines have an important influence on the alkali salt conditions of the surface, although not by gas exhalations—as Treitz believed, owing to lack of evidence in his day—but by the migration of internal saline waters of high temperature and high concentration. K. Telegedy-Róth (1950, p. 68) and Sümeghy "rehabilitated" the Treitz conception as honestly as they had earlier refuted it, thus giving some satisfaction to the memory of that outstanding Hungarian scientist so misunderstood by his contemporaries. The role of fracture lines controlling the chemical composition of groundwaters was recognized by Stefanovits, too (1956).

Apart from the above-discussed three sources of alkalizing salts (the weathering of volcanic rocks; the running waters saturated to various degrees by the solutions of surface salt deposits; and the salt content of internal and stratal waters reaching up to the surface), any other sources of salt accumulation appear to be of secondary importance. Secondary sources are the salt contents of eolian dusts and atmospheric precipitations that contain mainly chlorine, carbonates, sodium and gypsum.

Several authors refer also to the decomposition of marsh-plants, as having an accumulative role, which is quite plausible, as the bogs impregnated with stagnant salt waters are known to have halophytic vegetation (e.g. Lake Velence and Lake Fertő). This interpretation implies that the sziksoils in Hungary were formed within the areas of former marshes, which is partly true, indeed.

Most of the researchers simply hold Na salts to be decomposition products of rocks making up the surface, where the salt minerals are actually accumulated from the air or waters.

A further probable origin of salts has been recently recorded by Tauber and Rozanov (1957) and Szabolcs (1961) who suggest that under anaerobic conditions soda is likely to be produced by microbiological processes, due to the activity of sulphate-reducing bacteria. For example, Tauber holds that the Desulfibro and Sporafibro bacteria in the Pannonian beds of areas north of Lake Fertő are responsible for the turning of sulphated waters into carbonated and common salt ones.

In conclusion, the unusually extensive alkalization in Hungary is primarily due to the fact that the geological structure of the Great Plain, with all the characteristics of a closed continental basin, allows alkaline salt substances (loads of rivers, solutions, eolian sediments of high feldspar content) *to accumulate in the mother rocks which determine the chemical reaction of the soils.*

The role of hydrogeography. It follows from the hydrogeography of Hungary that the dissolved alkali salts cannot flow off freely, which is the second factor to be considered. Of course, the explanation that the cliffs of the Iron Gate "hinder" groundwaters running off the Great Plain is as bad a hypothesis as any, though after J. Szabó and Lanfranconi it was included as an annoying mistake in a recent book by Z. Fekete (1958). [The cliffs cannot prevent this flow, as the middle course of the Danube passes its lowest gradient at the Iron Gate (Báziás: 63.68 m a. s. l., Orsova: 43.87 m a. s. l.; distance: 77 km; gradient: 25.7 cm/km).] In contrast, a true hydrographical hypothesis reckons with the extremely slow and long flow of the rivers which cross the subsiding Hungarian basin (particularly before the regulation of the rivers).

Already Treitz discovered the correlation, according to which the slower and longer the flow of a river is, the higher its CO_2 and Na content. He refers to the Tisza as a typical example, whereas the rather swift water of the Danube, in his opinion, is less abundant in alkali. In addition, Mados and Zólyomi observed that "the calcium and magnesium in the Tisza are represented by hydrocarbonates, and a minimum calcium content sufficient to stabilize their solution is always present, so the water of the Tisza cannot have carbonate sediments". We sometimes have to consider also the age of the rocks in the drainage basin, e.g. that of limestones.

According to the above "a survey of the petrography of the mountains supplying the waters will also show what salts are likely to accumulate". The rather high amount of dissolved mineral-salt content of the rivers in Hungary can also be explained by the fact that the rivers of the sylvan steppes spring—as generalized by Funk—either from the forest zone or from the steppe zone. In Hungary, where the former is the case, the leaching of salts is known to be very intensive in the forest zone. With similar plausibility Viliams states that "in steppes irrigated by mountain rivers and subjected to strong weathering, sodium and chlorine are being accumulated continuously".

However, it is not only the rivers that supply the basin with waters coming from the marginal mountain ranges, for subsurface waters also flow there in abundance. The sources of the groundwaters are a subject of debate between geologists and hydrologists. Geographers have good reason to support the geologists as against water-engineers, except in certain special instances. The geologists hold that the bulk of flood-plain waters as well as groundwaters drilled for on the Great Plain are recharged from the fluvial talus fans of the marginal areas, fracture and fault systems and the deep-buried subbasin continuation of the karst rocks of North Hungary. This seems to be confirmed by the high salt content of the waters throughout the Great Plain. Fig. 3a–c may also be considered as proof that the salt concentration increases towards the ancient deep zone of the Great Plain Basin, marked by the rivers Ér, Körös and Lower Tisza. The $NaSO_4$, NaCI and Na_2CO_4 contents of the groundwater are closely connected with the process of alkalization. A collation of the data in Fig. 4a–c, representing the standpoint of the water engineers, will show that in dry years the intense evaporation allows very little if any run-off on the Great Plain. Nevertheless, groundwaters are abundant even in such periods; in fact, the rivers themselves take up some groundwater owing to infiltration. Therefore, in our opinion, groundwaters cannot be derived from merely local precipitations.

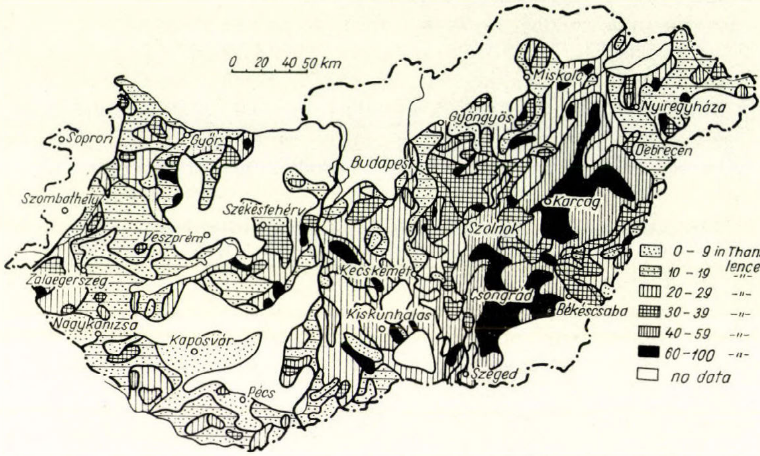


FIG. 3a. Sodium content of groundwater samples (A. Rónai 1956)

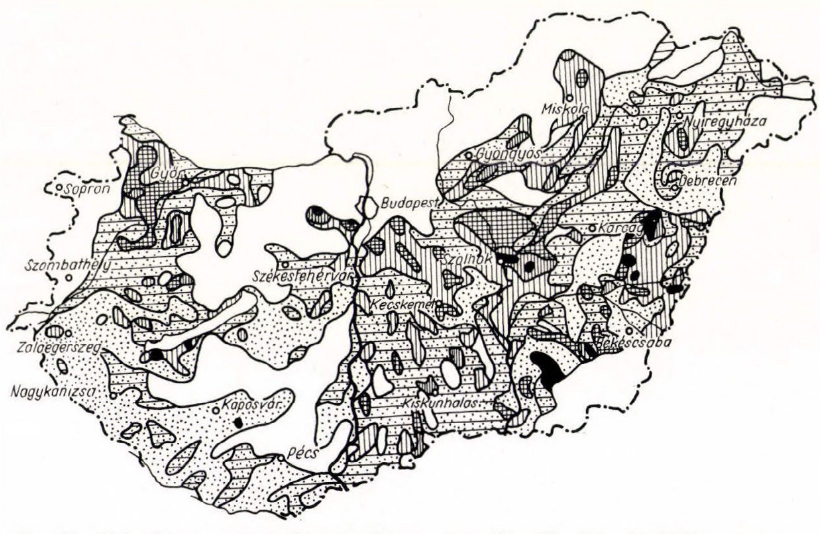


FIG. 3b. Chlorine content of groundwater samples (A. Rónai 1956)

Considering their composition, we can easily realize that groundwaters arriving at the surface or the sub-surface zone, will cause an intensive alkalization (Mados 1943).

The influence of the relief. While examining groundwater depths offering favourable conditions for alkalization, we are practically dealing with the third controlling factor, i.e. the influence of local reliefs. From J. Szabó to Szabolcs (1961), almost every investigator has recognized the fact that

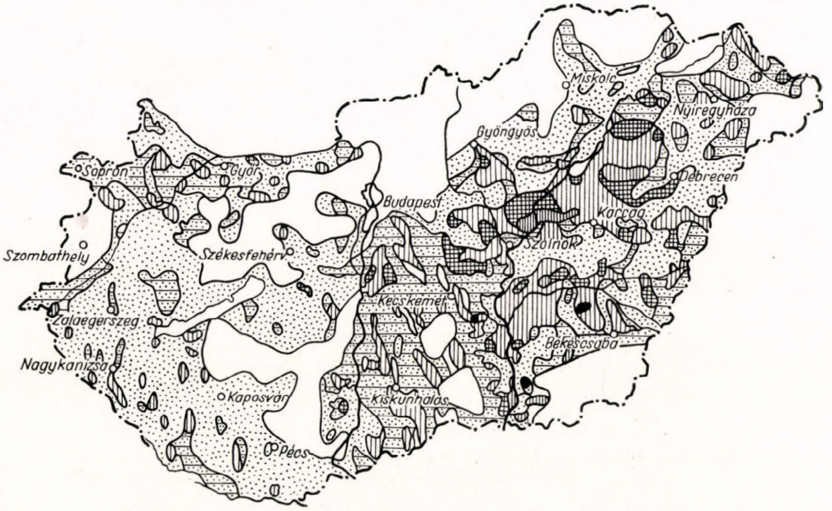


FIG. 3c. Sulphate content of groundwater samples (A. Rónai 1956)

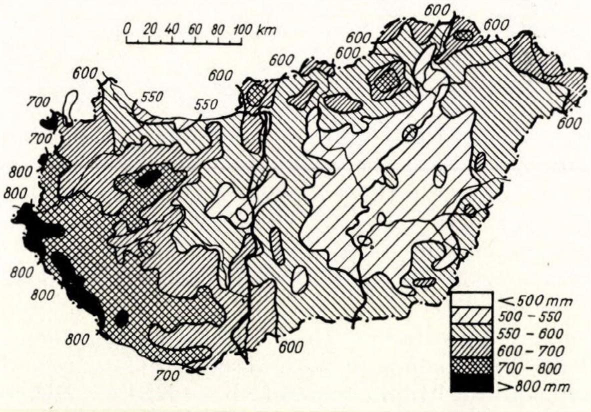


FIG. 4a. Annual rainfall averages, 1901—1940 (F. Hajósy 1952)

sziksoils are to be found not in the depressions but rather on the low-seated edges of surface reliefs and on portions emerging from intermittently stagnant waters. (Of course, salt efflorescences such as occur in the dried-up flat stream beds or in the bottom of pools during hot summers, are excepted.) Inkey had made an attempt to classify sziksoils in the terms of the surface features in which they generally occur, but Mados was the first to come to a true interpretation of the genetical bearings of the above phenomenon; his results have been confirmed by the investigations of Szabolcs. It should be noted, however, that the "third" agent works in a close interaction with the meso-climate, though the latter cannot be harmfully active unless the local relief makes it possible.

Mados (1943), Ubell and Kovács hold that water reserves can accumulate on the Great Plain from October till March only; from April to September the precipitations evaporate or are used up by the plants (Treitz 1924). According to Mados, precipitations of the winter half-year averaged from 215 to 244 mm in the Trans-Tisza Region for the period from 1899 to 1920,

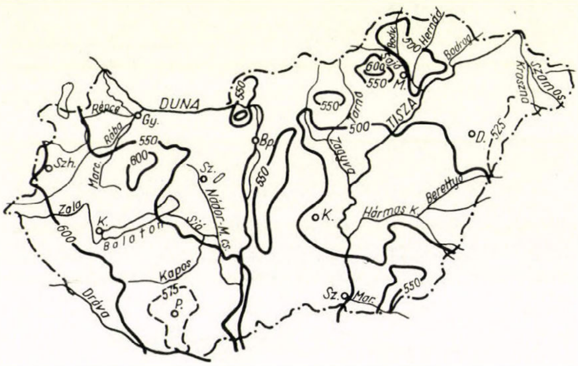


Fig. 4b. Multi-annual averages of evapotranspiration in Hungary (K. Szesztay 1959)

which makes about 40% of the total annual amount. This is sufficient to keep the annual water reserves at the water-absorbing capacity of the soil. Since the capacity of a layer 10 cm thick is about 16 to 17 mm, the above amount of 215 to 244 mm can penetrate a depth of 130 to 150 cm, so winter precipitations can rarely reach a depth of 2 m. Accordingly, the salts in the upper soil horizon can be leached out up to this limit. Hence, no surface alkalization can take place where water-resisting layer is not present within a depth of 2 m, or where the groundwater, i.e. the zone of capillarity, does not rise above this depth (Mados 1943; compare with Treitz 1924). According to Mados, the loess ridges in counties Hajdú, Szolnok, Bács-Kiskun, Békés and Csongrád, if not contiguous with flood plains, are not alkalized. In these areas the highest level of groundwater lies below 2 m (Mados 1943).

Where the water table rises, though periodically, as high as 120 cm below the surface or still higher, salts will possibly accumulate on the surface or near it, owing to capillary water elevation (see the subsoil alkalization of loesses or, as designated by Stefanovits, the "chernozem soils with subsoil alkalization in Hungary"). On the edges of flood plains, where during inunda-

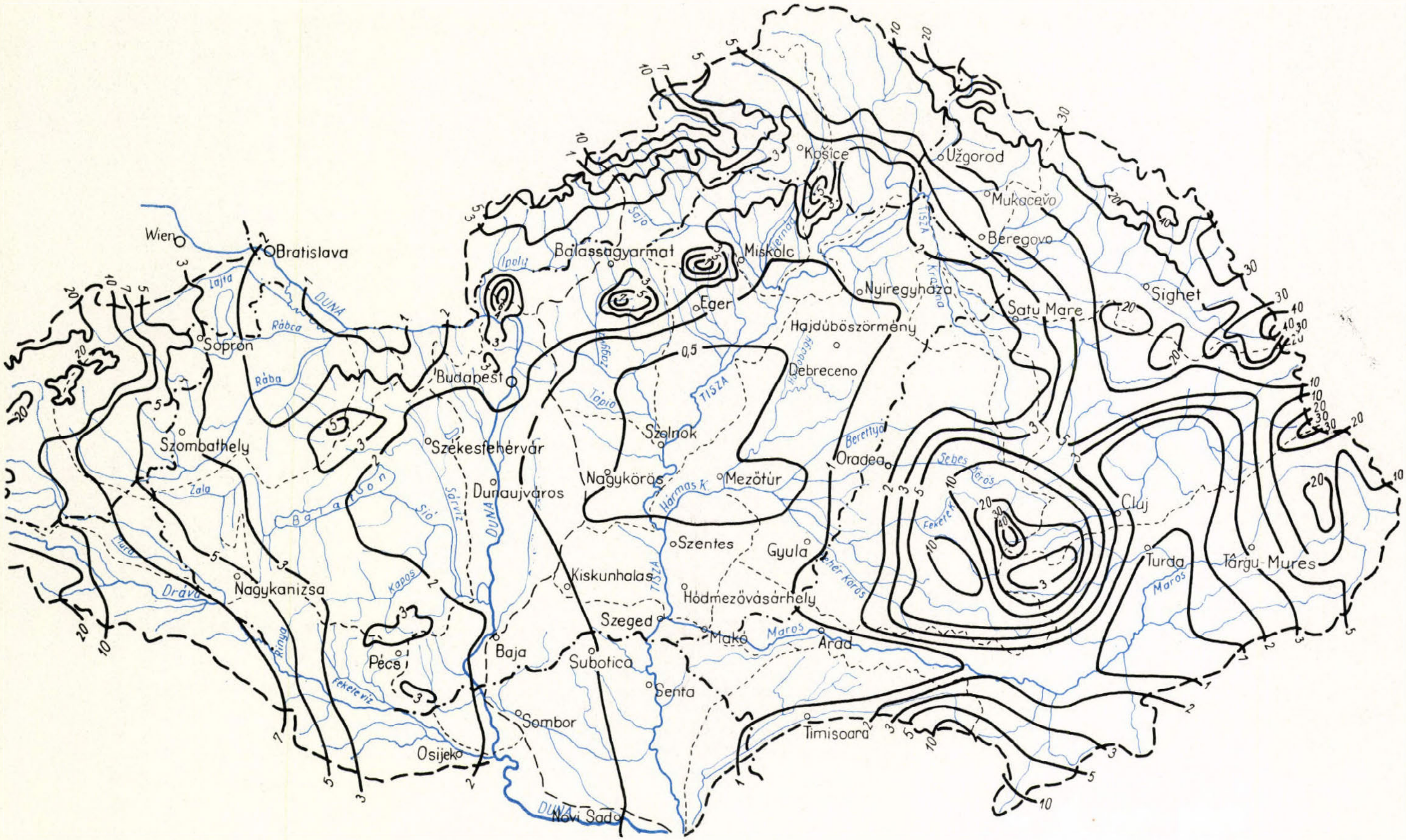


FIG. 4c. Multi-annual averages of the specific rate of flow in the drainage areas of the Hungarian tributaries of the Danube (W. Lászlóffy 1958)

1. —·— frontier; 2. ——— primary watersheds; 3. - - - secondary watersheds; 4. ~ 6 ~ specific rate of flow, l/sec/km²

tions the water table rises, this alkalization of suboils takes place at depths of 70 to 80 cm, occasionally at about 100 cm, below the surface (Mados 1943; Endrédy 1941; Stefanovits 1956). If the water table sinks below 2 m, there

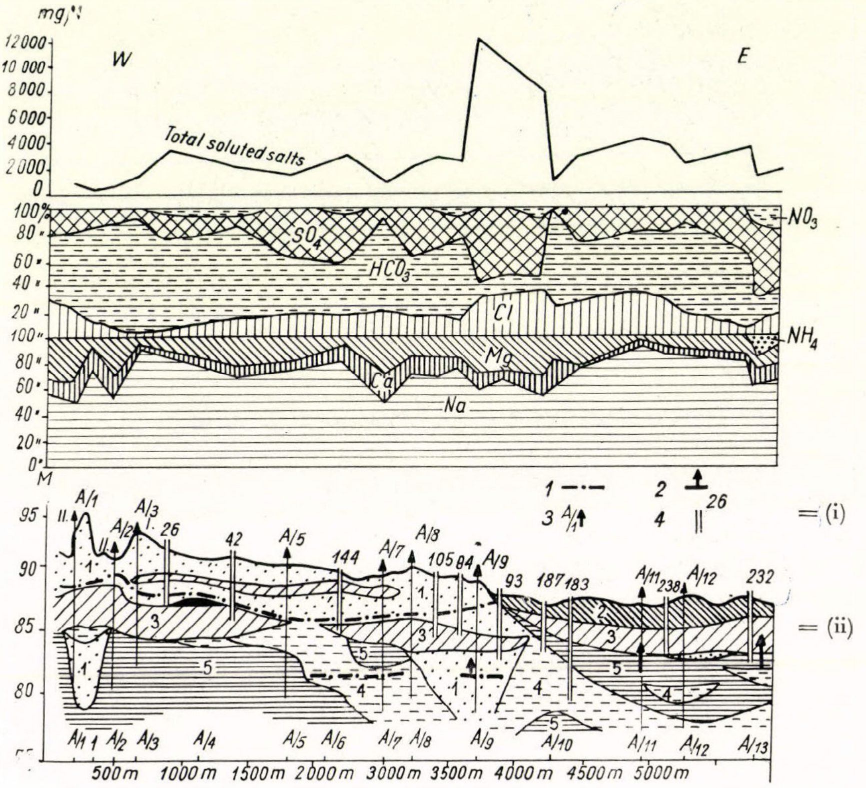


FIG. 5. Relationship between the geological conditions and the quality of the groundwaters in the bore-holes of Szabadkígyós (A. Rónai 1956)

(i) 1 = Occurrence of groundwater; 2 = Rise of groundwater; 3 = Site and number of bore holes; 4 = Site and number of wells (ii) 1 = Fine-grained Holocene fluvial sand; 2 = alkalized loess loam; 3 = fine-grained Holocene sand loess; 4 = Holocene loam; 5 = Holocene clay

is nothing to fear, because the salts ascending with the soil solution get more and more concentrated and thus cannot reach the roots of the plants by capillary action. Nevertheless, alkalization can take place above that water table, i.e. above the zone of capillarity—if the solution is concentrated in the so-called intermediate layer between the soaky upper soil and the zone of capillarity; however, owing to its deep position, it does not influence agricultural production. These "deep-seated" sziksoils are easy to detect by the succession of the salts precipitated; lime-, gypsum-, sodium salts subside one after another in that order (Stefanovits 1956).

If the water table has a periodical rise, or is kept permanently high by a water-resisting layer, the situation is not very dangerous, because the salt solutions brought up to the surface in humid years are carried off by natural drainage. *But in drainless depressions, oxbows or bottom-lands*, where salts can easily effloresce (Mados 1943), sodium salts, precipitating out last, will cover the surface. Of these salts, usually $NaSO_4$ and Na_2CO_3 having the quickest ascent, are most likely to effloresce (Treitz 1924; I. Szabolcs 1961). This explains why the belt of most intensive alkalization is not situated at the bottom of the alkalized depression, but on its gentle slope, or, as put by Stefanovits (1956), "it surrounds the waterlogged depressions like a collar" (Treitz 1924).

The Mados theory is perfectly confirmed by a profile, taken by Rónai near Szabadkígyós, which shows the highest concentration of salt solutions where the water table has risen up to a level of 1.5 to 2 m below the surface (Fig. 5). Rónai's data on the depth of groundwaters (Fig. 6a, b) agree, from this point of view, with the general map of the spread of sziksoils, as well (Fig. 7). Considering the above, we can understand why alkalization is imminent when the water table, elevated by irrigation, reaches 2 m, i.e. the given limit of danger (Rónai 1955; Stefanovits 1956). *It can be stated furthermore that the drainage works and river controls must have influenced the areal extent of alkalization, because in some areas they have reduced the harmful elevation of the groundwater table, while other areas, which might have been "well-drained" under the former high water-level conditions, have now become drainless.* Accordingly, the consequences of the anti-inundation works may affect agriculture both positively and negatively.

One may raise the question as to what factors are responsible for the varied micromorphological patterns, allowing sziksoils to develop within the above-mentioned narrow limits of height, on the Great Plain, which is generally referred to as a textbook example of the slightest possible relief undulation (Fig. 8). The answer can be found in A. Papp's map-scheme of the Sárrét Region of the Great Plain, which shows an entangled network of palaeostreams (Fig. 9); also evidenced by the sections and sketches of Sümeghy, Rónai, and other geologists who had surveyed that area. According to these maps, etc., the varied micromorphological conditions of the Great Plain have resulted from the peculiar development of its drainage system, which allows but a very incomplete run-off. (This holds true for all the areas in the Great Plain, except those covered by sand, which in turn are influenced by other factors.) This is the reason why we give primary listing to hydrographical factors as working against relief, when dealing with the preconditions of alkalization.

Earlier, some authors, e.g. Endrédy, Kreybig, Fekete, Nagy and Korpás (1956) held that the influence of the relief is shown according to the absolute height above sea level. However, it follows from the above, as well as from the values of infiltration and leaching as clarified by Mados and recently by Szabolcs, that it is *never the absolute height a. s. l., but always the difference of level in relation to the base level that plays a decisive role in the relation between*

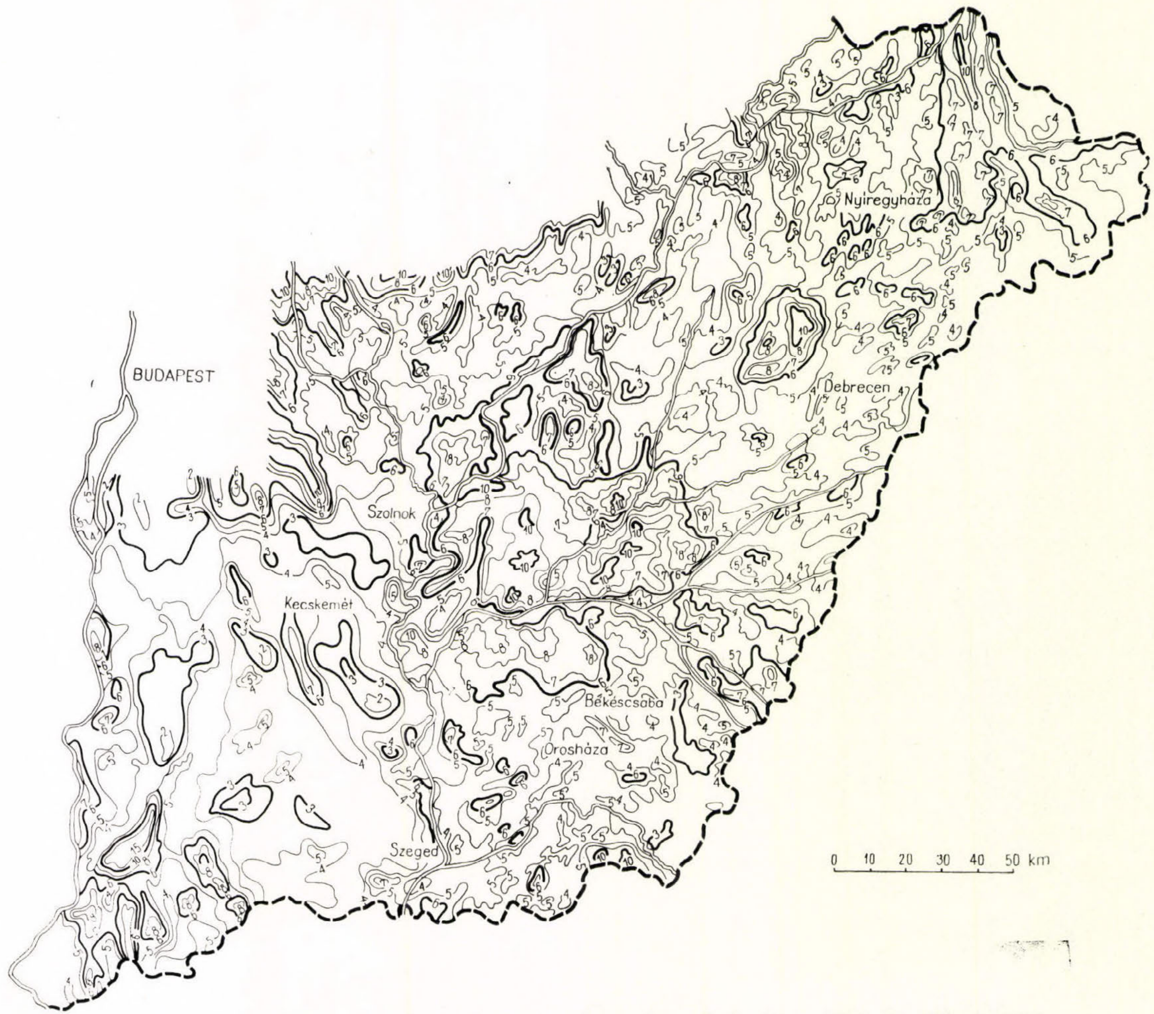


FIG. 6a. Deepest groundwater tables under the surface of the Great Plain (A. Rónai 1961). Isolines of depths in meter

4*

Fig. 6b. Highest groundwater tables under the surface of the Great Plain (A. Rónai 1961)

alkalization and relief. These considerations were set forth first by Inkey and later in a paper by Zólyomi. The above-mentioned relationship shows itself in the position of the belt of alkalization above the groundwater table.

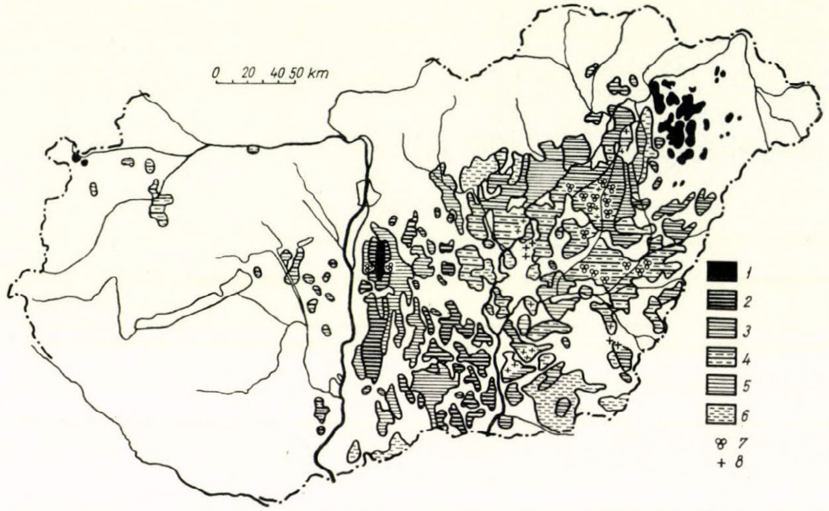


FIG. 7. Spread of sziksoil types in Hungary (I. Szabolcs and F. Jassó 1958)

1 = Solonchak; 2 = Solonchak-solonetz; 3 = Meadow solonetz (Rough and medium, often mixed with solonchak) 4 = Meadow solonetz turning into step-type soil (medium and deep); 5 = Meadow soil with solonetz; 6 = Meadow chernozem with salt concentration; chernozem, 7 = Soils turning into solod; 8 = Secondary (artificial) sziksoils

FIG. 8. Contour map of Hungary (P. Stefanovits 1956)

That the sziksoils in most cases range at heights of 84 to 94 m a. s. l. —as pointed out by A. Nagy and Korpás (1956)—follows from the fact that the mean water-level of the rivers, as well as the groundwater table, usually lies a few m lower than this figure. It can also be inferred from our data—by a comparison with Fig. 6—that where the distance between the base level and the level of sziksoils exceeds 4 m, alkalization is likely to be caused by the insufficient drainage. So, in such cases it is not the groundwater table, but the evaporation of the precipitations that must be primarily responsible for alkalization. Such is the case with the high-seated sziksoils of the Nyírség, as well as those of the Sand Ridge in the Danube—Tisza Midregion, which cover either flat depressions, or longitudinal troughs surrounded by sand

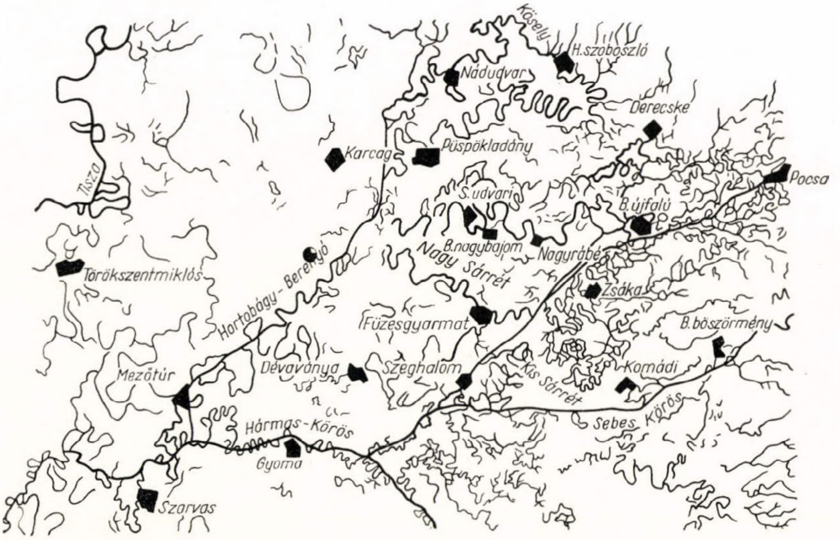


FIG. 9. Abandoned river beds in the Sárrét (A. Papp)

dunes, or abandoned channels. This is also demonstrated by the groundwater migration and the spread of soil types mapped in Fig. 10a, b, according to which the sziksoils of the Szatmár Plain are to be found mostly in depressions where the precipitations or groundwaters migrating from the rivers evaporate. A correlation with the height a. s. l. is naturally wrong not only as regards the position of sziksoils but also that of the other soil types.

Other factors. Climate is mentioned in the succession of tectonico-geological, hydrographical and relief factors in the fourth place only. Earlier researchers ascribed it a greater importance. Its influence, however, is preceded, or rather, prepared for by the other factors. The example of the Baraba Steppe shows (Szabolcs 1961) that the intrazonal character of sziksoils should be understood in a wider sense than is usual, precisely because the other factors permit alkalization in areas where the climate alone would be insufficient.

It has also been demonstrated by data on evaporation, water economy and air moisture gathered by Scherf (1928) and others that Hungary has a peculiar climate, humid in winter and arid in summer, owing to its transition character between oceanic and continental climate (Fig. 1, 3 and 11).

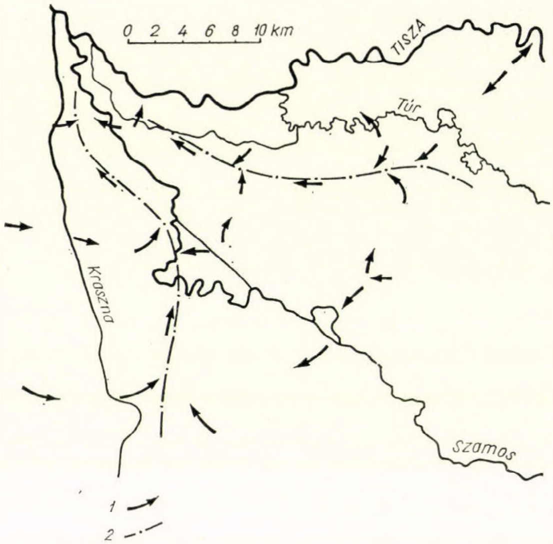


FIG. 10a. Trends of groundwater migration in the Szatmár Plain (E. Szebényi 1954)

1 = Current of groundwater; 2 = Groundwater level

FIG. 10b. Sketch of soil types in the Szatmár Plain (P. Stefanovits 1954)

1 = Flood soils; 2 = Meadow soils; 3 = Bog soils; 4 = Forest soils; 5 = Sziksoils; 6 = Buried humus horizons; 7 = Subsoilwith $CaCO_3$ content; 8 = Subsoil with $CaSO_4$ content

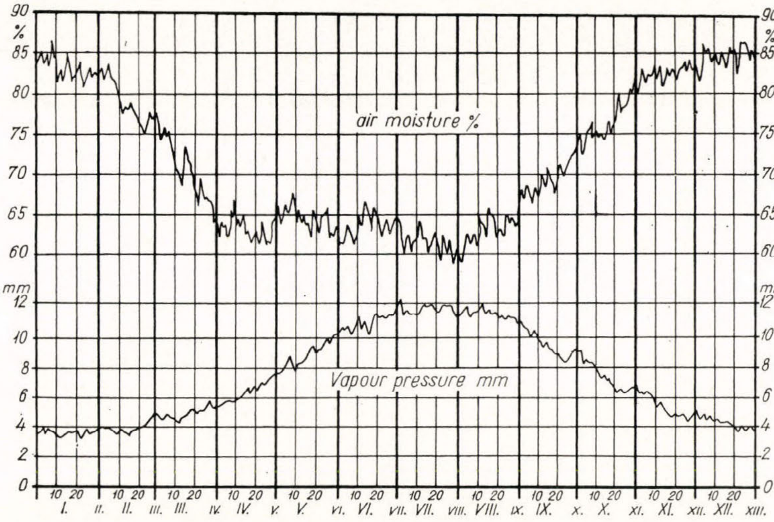


FIG. 11. Seasonal variation of air moisture and vapour pressure in Budapest, 1871—1950 (N. Bacsó, J. Kakas and L. Takács 1953)

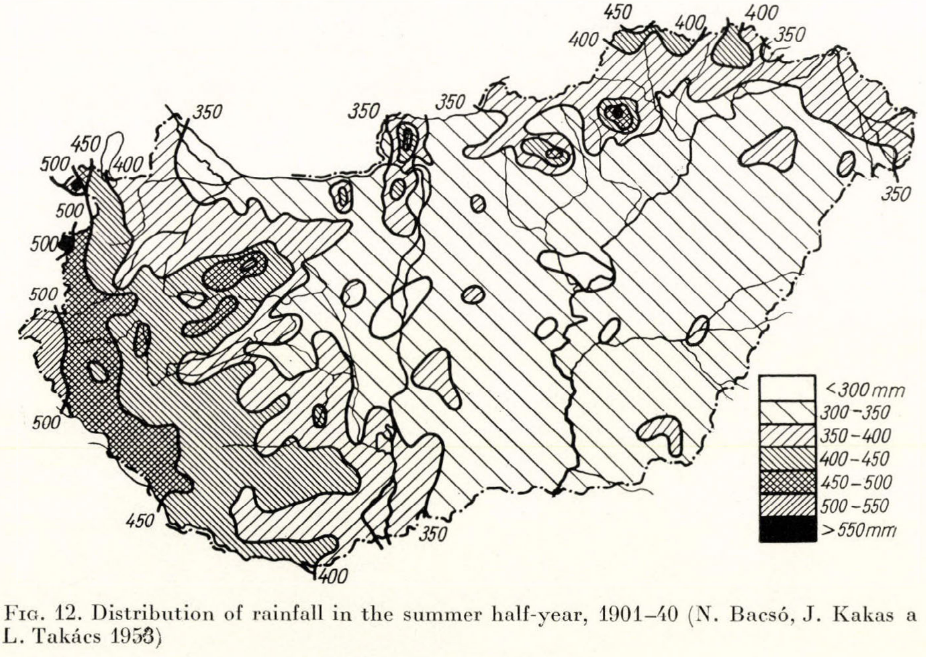


FIG. 12. Distribution of rainfall in the summer half-year, 1901–40 (N. Bacsó, J. Kakas a L. Takács 1953)

It is the arid summer that permits ascending soil solutions to get supersaturated and so to precipitate their alkali salts either on or near the surface. And this is the reason why stagnant waters, evaporating from the surface of some closed depressions, leave the salts behind. It can be observed that sziksoils in Hungary are strictly confined to areas where the rainfall in the arid half-year amounts to less than 350 to 400 mm. Because of the present climate of Hungary, only an unusually abundant rainfall could bring about a perfect wash and leach of the surface (Figs 6 and 12). So we may state that their formation begins either on meadow soils or on chernozem, which also proves the intra- and extrazonal character of the sziksoils. We may assume, furthermore, that climatic and soil conditions have not changed essentially since the time sziksoils first appeared.

Nevertheless, we can frequently observe that waterlogged soil in high elevations becomes alkalized (on loess ridges for example) even when apparently well-drained. Hence, we have to add a fifth factor to those discussed above, namely the *impermeability of the subsoil.* (We do not mean here the stage when alkalization has rendered the subsoil impermeable for both ground- and meteorological waters, but the state preceding it. It is the special geological evolution of the deposits on the Great Plain that caused the rivers to accumulate the finest weathering products of their drainage system in these vast areas. These fine-grained silty-clayey sediments had readily turned into impermeable flood-plain earths and clays. Of the eolian sediments occurring here, the "Alföld" loesses have similar properties. They are also termed "infusional loesses", to stress their different genesis from that of other loesses with good vertical permeability. Their tendency to mingle with fluviatile materials, and their having been inundated for a while after being deposited, are also included in the term. So the agents promoting alkalization are aided by poor permeability, which renders it possible for long-stagnating groundwaters to concentrate salts in areas where the relative height of the surface would otherwise not justify it. Since this factor results from geological, hydrographical and relief agents, it may be considered last.

The mother rocks cannot be ranked among the factors of alkalization because their two possible types occurring in the Great Plain, (eolian sediments and fluvial alluvia) have been filled with saline solutions and weathering products, under the influence of the other factors which also control their formation into various soil types. In fact, both szik- and meadow soils have been formed on loesses as well as on flood plains (Stefanovits 1956; Szabolcs 1961). Therefore, we have to modify the conception according to which the spread of the soil types, including sziksoils, either in part or as a whole, is dependent on the original mother rock. Others emphasize the role of periodical inundation which, however, again results from the interaction of the hydrographical, morphological, climatic and subsoil factors, and therefore cannot be regarded as a primary agent.

Bibliography *

ARANY, S. (1956) A szikes talaj és javítása (The sziksoil and its melioration), Mezőgazd Kiadó, Budapest, 407

ENDRÉDY, E. (1941) A geológiai viszonyok befolyása Magyarország jelenkori talajainak képződésére (The influence of the geological conditions on the recent soils of Hungary), *FtIÉJ*, no. 5, Appendix, 176—91

FEKETE, Z. (1958) Talajtan és trágyázástan (Pedology and fertilization), Mezőgazd. Kiadó, Budapest, 410

MADOS, L. (1943) A szikesedés és a víz (Alkalization and water), *HK*, vol. XXIII, 3—21

A. NAGY, M., KORPÁS, E. (1956) A hazai szikesek talajföldrajzi vázlata (Sketch of the geography of sziksoils in Hungary), *FÉ*, vol. V, 161—84

RÓNAI, A. (1955) A magyar medencék talajvize, az országos talajvíztérképező munka eredményei, 1950—1955 (The ground-waters of the Hungarian basins; the results of the mapping of groundwaters throughout Hungary, 1950—1955), *FtIÉK*, vol. XLVI, 245

SCHERF, E. (1925—28) Az Alföld pleisztocén és holocén rétegeinek geológiai és morfológiai viszonyai és ezeknek összefüggése a talajkutatással, különösen a sziktalajképződéssel (Geology and geomorphology of the Pleistocene and Holocene beds of the Great Plain and their relation to the research of soils, particularly to that of the formation of sziksoils), *FtIÉJ*, vol. I, 265—301

SOÓ, R. (1951) A viliamszi talajfejlődési elmélet és a növényföldrajz kapcsolatai (Relationships between Viliams's theory on the evolution of soils and phytogeography), *BOK*, vol. I, 43—80

STEFANOVITS, P. (1956) Magyarország talajai (The soils of Hungary), Akadémiai Kiadó, Budapest, 252

SZABOLCS, I. (1961) A vízrendezések és öntözések hatása a tiszántúli talajképződési folyamatokra (The influence of the regulation of streams and irrigation on the soil-forming processes in the Trans-Tisza Region), Akadémiai Kiadó, Budapest, 367

TREITZ, P. (1913) Talajgeográfia (Soil geography), *FK*, 225—77

TREITZ, P. (1924) A sós és szikes talajok természetrajza (The natural history of the salty and sziksoils), Stádium, Budapest, 311

*A detailed list of references to the subject is given in *FK* 1964, vol. XII, no. 2

GEOGRAPHICAL TYPES OF AGRICULTURE IN HUNGARY

by GYÖRGY ENYEDI

The significance of the research into geographical types

In recent years Hungarian agriculture has undergone radical socio-economic changes. After a lengthy period of preparation, the socialist reorganization of agriculture was begun in 1958 and completed in 1961. The agriculture comprised of extremely disintegrated small holdings has been developed into a rural economy based on large-scale farming. In 1957 the peasant holdings averaged below 2 hectares, and even these small farms were usually split up into several parcels. Under such conditions the technique of agriculture could be improved only with extremely great difficulty. It was all the more urgent to speed up the process of reorganization, because industry developed much faster than agriculture during the last fifteen years. For instance, from 1949 to 1959 the production index of agriculture was increased by 30%, while that of industry was trebled. The slow growth of agricultural production was an impediment to the exportation of agricultural products (which is indispensable for the importation of industrial raw materials and equipment), so that it indirectly hampered further industrialization.

Under the archaic system of farming it was impossible to develop the industrial revolution in agriculture. The reorganization of the small holdings into big farms brought considerable results, even in the first years. From 1959 to 1961, the tractor park increased from 26,000 to 50,000 machines, the amount of fertilizers per hectare from 28 kg to 53 kg (in active ingredient), the size of the area under irrigation from 90,000 to 220,000 ha. The capital invested in agriculture during those three years equalled the total investments of the previous 14 years.

Of course, as yet Hungary has taken only the first steps in development of a system of modern large-scale farming. Further progress involves not only financial and technical problems, but also a rational distribution and specialization of agricultural activity, which, if effectuated in compliance with the physico- and economico-geographical conditions, may serve as the means for increasing production.

In Hungary the necessity of specialization has long been recognized. Various scientific projects aimed at the reorganization of the branches of agriculture had been propounded since the thirties. However, these projects seemed to be ineffectual because of the limited scope of small-peasant farming, so Hungarian agriculture remained underspecialized. The small farms mainly strove for self-sufficiency (autarchy) in that they produced grain crops (wheat or rye, or barley and maize, respectively) to meet only the local demands of population and livestock (even in areas where soil and other conditions were definitely unfavourable). This limitation dominated 70 to 80% of the crop area, so hardly any land was left for raising cash crops.

Since the introduction of socialist large-scale farming an increasing specialization has been observed. The acreage of bread grains has decreased. Vineyards, orchards, etc. have been planted at a quick pace. These changes, however, owing to lack of a comprehensive plan for areal reorganization, show, in part, symptoms of improvisation. Many plans and concepts for areal rearrangement in the various branches of production have been advanced, but all have the common defect of being based on the individual branches in themselves, omitting the interconnections of production and population as a whole. In our opinion, economic geography, with its synthetic approach, is able to determine and evaluate synchronously the geographical distribution of agrarian production in relation to physiographic environment, population, settlement network, industry and communication. Our aim is not to describe the geographical spread of the plant or animal species, but to determine the geographical types (regions) of agricultural production.

As a matter of course, our geographical studies are made to detect and evaluate the actual and existing areal division of labour; to make plans for the future is the task of economic planners. But if one has "only" been able to distinguish the current agrarian regions, one has already accomplished a work important both for science and economy. Ten years ago we began studying the geographical types of agriculture in Hungary, and then our aim was merely scientific. Now our work can already be regarded as a direct contribution to the development of agricultural production, too.

The method of determining geographical types

Many working methods are available for determining the geographical types in agriculture.

(a) In the Hungarian geographical and agraro-economic literature the *branch conception* predominated until the recent past. Specialists tended to determine the areal types (regions) simply by summing up the various branches of agricultural production, in many cases by plotting them on one another in the map. We became convinced of the drawbacks of this method, which is entirely analytical. So we began to develop synthetical methods suitable for defining agricultural branches of different types.

(b) In international literature the use of *cereal units* has been widespread; it is suitable for summing up various products, for determining the structure of production, for comparing production levels, etc. We consider, however, that this method can work in grain-producing areas only, as it offers no uniform principles for all agricultural products. For example: it compares food- and fodder-crops with carbohydrate content on the basis of their caloric value; but at the same time it evaluates industrial crops, as well as highly vitaminous plant foodstuffs and highly albuminous animal foodstuffs, on the basis of the labour required for their production. Since Hungarian agriculture is becoming specialized mainly along the lines of horticulture (vegetable-production, viniculture, fruit-production), the importance of these products *cannot be* adequately *expressed* by applying the cereal unit.

(c) The *land utilization survey* endeavours to embrace and reflect agrarian production as a whole by the forms of geographical interpretation, i.e. by cartographic representation. Many a devoted specialist of agricultural geography considers this method as the only basis of obtaining a reliable geographical typology in agriculture. Land utilization survey may be truly suitable for evaluating the interrelations between agriculture and physiographic environment. We are suspicious, however, that this method can bring into relief at best only some quantitative traits of plant-growing and can estimate stockbreeding only by the size of the area furnishing the fodder; in fact, the real economic value of the various plants (land utilization forms) and their produce cannot be adduced by this method in direct proportion to the size of the area. No true valuation of the geographical types, especially in countries of small areas with an underspecialized agriculture (like Hungary), can be obtained by the method of land utilization survey alone.

(d) The former method of determining production types by starting from the *physical conditions* is going out of practice nowadays. It is only too obvious that the utilization of the physical conditions depends on the stage of socio-economic development. Detection of these conditions is most useful in that it provides important evidence for agricultural planning, but by no means can we deduce the production types from the physical conditions.

(e) In some countries (United States, Soviet Union) the agricultural regions are determined by the farm types, with a view to specialization and geographical distribution. As a matter of course, this approach can only be applied where farms with a high level of similar specialization cover vast, continuous areas. In Hungary, however, the situation is different. Hungary is a small country, and its regions can never be highly specialized, not even when the farms themselves will have been intensively specialized; for various considerations (such as demands to be met by domestic production, the employment of the surplus labour of the dense agrarian population, etc.) suggest that a great variety of farm types will continue to exist in the future.

(f) In our opinion, *considerations and methods* are borrowed from the science of national economy indispensable for the determination of the geographical types of agriculture. The best method for summing up the various products is to use (instead of the cereal unit) the *value produced* (expressed in monetary units): its composition can best reflect the specialization, and its size (related to the size of land and to the number of agricultural bread-winners) is the most sensitive index of the production level (though changes in price may cause some inaccuracies). Similarly it is important *to study the market production* (which reflects the function of the individual agricultural regions in the geographical division of labour) together with the other economic indexes. The agricultural geographer's classification and typology are, however, not equal to those of an agrarian economist. Agricultural geography studies the agrarian production in its interrelations with the physiographic environment, the geographical distribution of the population, and other production branches. The current agraro-economic conception, which determines the types of production exclusively on the basis of the structure of gross production value, is one-sided and excessively generalizing for Hungary.

(g) These methods are, in one respect or other one-sided, each of them stressing but one feature of agricultural production. And we are of the opinion that the prevailing agrarian production complex cannot be expressed by a single index or a map. Therefore, *for determining the geographical types of agriculture in Hungary*, we have chosen to apply various methods, each of them suitable for partial-researches only but compensating for the deficiencies of the others with comprehensive investigative procedures.

At the beginning of the fifties the preliminary evaluation of the *physical conditions* was fulfilled by a team of workers, consisting of rural economists, physical and economic geographers. They examined the possibilities of all the field crops cultivable in Hungary by going into details such as the thickness of fertile soil layer, the changes of precipitations and temperature during each ten-day period, the groundwater table, etc. Other institutes carried out special surveys concerning the physical grounds for the allocation of viniculture and fruit production.

The *individual branches of agriculture* have also been studied, and the researches for the most part have been published. We determined, in common with Tivadar Bernát, the actual regions of the field crops. In doing so, we used a formula covering the size of the crop area as well as the level of the average yields (the regions were fixed on the scale of the municipal districts). The computation was made in the following way: the yield obtained for the municipal district $\left(\frac{y}{s},\right.$ where $y =$ the yield of the respective crop, $s =$ the sowing area of the crop) was plotted against the *total* crop area (T) of the district $\left(\frac{y}{s} \cdot \frac{s}{T} = \frac{y}{T}\right)$. This ratio presents the average yield computed for the total area of the district. After having related it to an index computed in a similar way on *national* scale $\left(\frac{s_n}{y_n} \cdot \frac{s_n}{T_n} = \frac{y_n}{T_n}\right)$ (n indicating areas and yields on national scale), we obtained the so-called productivity coefficient $\left(\frac{y}{T} : \frac{y_n}{T_n} = \frac{y}{y_n} : \frac{T}{T_n}\right)$. Let us illustrate this by an example. Of the national crop area of 5.7 million ha, wheat is grown on 1 million ha with a yield of 15 quintals per hectare. Thus the yield total makes 15 million quintals. In one (A) of the districts the total crop area is 50,000 ha, that of wheat is 15,000; the yield of wheat amounts to 23 q/ha, the yield total makes 345,000 quintals. The index for the district (A) is 2.62, i.e. the area of the district is by 162% more productive for wheat than is the total crop area of the country.

As to the distribution of the agricultural labour as well as the stock-breeding areas, researches have already been or are to be accomplished by the Geographical Research Institute of the Hungarian Academy of Sciences.

Similarly thorough analyses of the geographical structure of agriculture are provided by the regional monographs, which deal with all the bearings of agriculture within the regional units, even the micro-regions (i.e. the smallest basic units) of the geographical division of agricultural labour. These studies, carried out on the parish scale, have already been completed for the greater part of Hungary's agricultural area.

Finally, the analytical investigations were followed by the land utilization mapping. The latter has been performed partly on a synoptic scale (1 : 200,000);

but in addition detailed surveys (1 : 25,000, occasionally 1 : 10,000) have been carried out in some select type areas. These maps, as was mentioned, cannot be used in Hungary as *a basis* for typology, but they contribute material to a characterization of the types determined by economic synthesis.

The geographical types of agriculture were established by the author on the scale of municipal districts throughout the country. Each type has been determined in terms of characteristic production branches (representing some specialization). A branch was regarded as characteristic:

if it provided at least 20% of the value of the total agricultural products;
if it accounted for at least 20% of the value of cash products;
if the yield per 100 ha (within the district) exceeded the national average.

The choice of these conditions were motivated by the following reasons:
The most comprehensive synthesis of the production branches is naturally given by the value produced. The given limit value of 20% is an empirical figure (it also indicates the relatively low specialization of Hungarian agriculture), which we have not treated rigidly; rather in marginal cases, we have relied on the results of the analytical studies. The *internal* structure of production is best expressed by the composition of the production value.

On the other hand, the analysis of the market production reveals the *external* relations of production, i.e. the production branches which play a considerable role in the national division of labour. A leading group of Hungarian rural ~~economists holds~~ that the analysis of the market production is negligible, having a structure essentially identical with that of the production value. Our calculations have refuted this suggestion. Since the traditions of self-sufficiency farming still survive in Hungary, the geographical distribution of some production branches (cereal-growing, pig- and poultry-breeding) runs parallel to the density of agricultural population. Consequently, the production ratio of these branches is high in regions of high density of agricultural population, even though they do not play any considerable role in the specialization. This is why we considered it necessary to set apart the production for self-sufficiency, when analysing market production.

The third condition concerns the size of the production, which also qualifies the branch. In towns, industrial regions, and mountain areas even quantitatively insignificant branches may represent a high ratio within the structure of agricultural production, for in such areas agriculture plays quite a subordinate role. These non-agricultural regions have been ranked as a special type. And, finally, a further type was found, the production branches of which have satisfied none of the above conditions; it is characterized by a mixed farming, its specialization being most primitive.

By the above method the following production branches have been brought into relief as characteristic of specialization in Hungary: 1. cereals, 2. potato, 3. vegetable, 4. fruit, 5. viniculture, 6. cattle-breeding, 7. pig-breeding, 8. poultry-breeding.

Since it is in insignificant areas that bread grain and potato have come up to the allotted special line of production, we can draw the general conclusion that specialization in Hungary is represented by either stock-breeding or horticulture. It is striking that industrial crops have nowhere met the conditions required of a "characteristic branch of production".

The course of analysis revealed some municipal districts where production could be characterized by a single branch, while other districts had two branches. (No district has been found with more than two branches which meet the above conditions.) The agriculture of the towns and industrial regions, as well as the mixed farming in the villages, have been referred to above as forming a special type.

Geographical types of Hungarian agriculture

After the production types of the Hungarian agriculture had been determined by means of the above working method, our next objective was to determine the geographical distribution of these types.

As a rule, they form continuous areas and are coherent agricultural *regions*, with the exception of those municipal districts where the production types, owing to special circumstances, represent isolated spots in a mosaic-like pattern (e.g. cattle-holding and wine-growing), and of those urban (industrial) areas, where agriculture has a supplementary character and is not determined by the general trends of agricultural development. In consonance with the above, an agricultural region covers the production type defined geographically.

Although the regions so defined are not merely hypothetical, their differentiation cannot be regarded as completely valid. A more detailed survey on the parish scale may well modify the boundaries and reveal more varied types.

The territory of the country has been divided into 14 farming types (regions). The division reflects the results of all the phases of the preliminary investigations.

These regions indicate, on the whole, the specialization that had taken place within the scope of small-peasant farming, prior to mass collectivization. Large-scale farming will ultimately modify these conditions, but for the present the traditional growing areas are to be regarded only as a basis for future specialization.

The fourteen regions are as follows: 1. Little Plain, 2. South-West Transdanubia, 3. Transdanubian Central Mountains, 4. Balaton Region, 5. Mezőföld, 6. South-East Transdanubia, 7. Danube Valley, 8. The Surroundings of Budapest, 9. Central Mountains of North Hungary, 10. Foreland of the Central Mountains of North Hungary, 11. Tisza Region, 12. Danube—Tisza Midregion, 13. Nyírség and Szatmár-Bereg Plain, 14. South-West Great Plain.

These regions show a wide variation of specialization and character. The chief types of production most often feature cattle- or pig-breeding, or some branches of horticulture. Regions 1 and 2 are characterized specifically by cattle-breeding; regions 6 and 9, and 13 to some extent are also cattle-breeding. Regions 7 and 11 are of the pig-breeding type, while in region 14 this branch of production is coupled with poultry-farming. Various branches of horticulture distinguish production in regions 4, 8 and 12. Finally, in regions 3, 5 and 10 none of the production branches fulfil the above conditions of typology, so they must be characterized by mixed farming.

None of the regions is exclusively agrarian. Industrialization has cut down the ratio of agricultural population, that 30 years ago was about 60%, by nearly half. Now it does not reach 60% even in regions of the truest agricultural character. In some regions agriculture is only a subsidiary economy, but certain branches (e.g. production of vegetables and fruits in the surrounding belt of Budapest where the agrarian population is as low as 9.8%), may still play a considerable role.

In Hungary, the density of agrarian population still controls the development of production types. The emphasis on horticulture requires masses of qualified labour (great improvement is expected from CMEA [Committee of Mutual Economic Assistance] collaboration). In regions 11 and 14, which are marked by a low density of agrarian population, the area ratio of cereals is high; whereas in the horticultural areas, notably in regions 4, 8, 12 and 13, the ratio of acreage labour is low (Table I).

TABLE I

Proportion and density of agricultural population

Regions	Total population	Agricultural population	Ratio of agr. popul. (%)	Acreage labour/cap. (in ha)
1. Little Plain	735 210	228 697	39.2	1.77
2. South-West Transdanubia	618 095	325 512	52.6	1.71
3. Transdanubian Central Mountains	437 621	99 850	22.8	2.15
4. Balaton Region	196 526	87 740	44.6	1.64
5. Mezőföld	338 796	164 238	48.4	1.96
6. South-East Transdanubia	474 095	176 362	37.1	1.96
7. Danube Valley	432 698	222 409	51.4	1.81
8. Surroundings of Budapest	2 614 794	257 180	9.8	1.82
9. Central Mountains of North Hungary	549 390	164 331	29.9	2.22
10. Foreland of the Central Mountains of North Hungary	542 190	165 121	30.4	1.67
11. Tisza Region	1 114 262	549 043	49.2	2.00
12. Danube—Tisza Midregion	737 512	3, 8 668	49.9	1.73
13. Nyírség and Szatmár-Bereg Plain	611 210	361 466	59.1	1.30
14. South-West Great Plain	574 131	309 524	53.9	1.63

Now the distribution of the agricultural land is fairly uniform. On a national scale, about 12% of the total land is owned by state farms, 80 to 82% by farmer's co-operatives, and the proportion is nearly the same in every region. In regions 4, 10 and 12 the percentage of private farms is relatively high (over 10%), since unlike the arable lands, it was impractical to unite the small vine parcels, which are highly prevalent there, in big farms; so that in these regions the structure of production still reflects the pre-war property relations. In regions 8, 10 and 12 the intense horticultural character of production was fostered by the fact that, owing to a peculiar history, the latifundia there could play no important role before World War II, and the predominant small-peasant farms had to introduce labour-absorbing branches to occupy their great excess of manpower.

The principal forms of *land utilization* show no fundamental divergences. Owing to the mainly level or slightly undulating topography, climatic conditions and relatively dense population, crop-farming comes everywhere to the fore. Arable land, in general, makes up more than 60% of the total agricultural area, and in two regions its proportion rises above 80% (Table II).

TABLE II

Main forms of land utilization (percentage distribution)

Regions	Arable land	Meadow	Vine	Garden	Pasture	Total agricultural area
1. Little Plain	79.2	8.7	0.9	2.1	9.1	100.0
2. South-West Transdanubia	69.2	15.1	2.4	3.1	10.2	100.0
3. Transdanubian Central Mountains	69.0	8.7	3.0	2.1	17.2	100.0
4. Balaton Region	60.5	13.9	5.7	2.7	17.2	100.0
5. Mezőföld	79.6	6.6	2.3	2.0	9.5	100.0
6. South-East Transdanubia	74.5	9.2	2.9	2.4	11.0	100.0
7. Danube Valley	76.7	5.2	4.4	1.6	12.1	100.0
8. Surroundings of Budapest	75.4	6.5	4.7	4.1	9.3	100.0
9. Central Mountains of North Hungary	69.4	8.9	1.1	3.0	17.6	100.0
10. Foreland of the Central Mountains of North Hungary	66.4	10.2	6.8	3.8	12.8	100.0
11. Tisza Region	74.0	4.3	1.2	1.7	18.8	100.0
12. Danube—Tisza Midregion	66.5	8.7	9.0	1.2	14.6	100.0
13. Nyírség and Szatmár-Bereg Plain	85.0	5.3	1.2	2.1	6.4	100.0
14. South-East Great Plain	83.6	1.4	0.2	2.4	12.4	100.0

Meadows are wide spread in western Transdanubia and in the Central Mountains of North Hungary. Their yield is significant, although the grass of the flood plains is often of low quality. The areal distribution of meadows is parallel to that of cattle breeding.

Pastures are most extensive in the mountain areas, in the centre of the Great Plain and in South-West Transdanubia (region 2). But it is in the latter region, the most humid area of Hungary, that the really good quality grasslands are situated. The mountain pastures lying mostly in karst areas possess relief conditions that are best utilized by sheep grazing. The most extensive pastures of the country have been formed in the driest central part of the Great Plain (region 11), on sziksoils unsuitable for tillage. They have a very poor grass yield, get almost scorched during droughts, and can only be used for sheep grazing. The natural grasslands play a much more subordinate role as fodder resources in Hungary than in Atlantic Europe.

Viniculture is favoured more or less in every region, but often for self-sufficiency only. Its areas are most extensive in the Sand Ridge of the Danube—Tisza Midregion (region 12); and the wine areas of the best quality lie on the southern slopes of the Central Mountains of North Hungary (region 10) and in the Balaton Hill-country (region 4). In the mountainous wine-districts the best vintages are produced because of weathered volcanic soils,

TABLE III

Percentage distribution of the crop fields according to regions 1—14

Crop groups	1	2	3	4
1. BREAD GRAINS:				
Wheat	19.1	21.5	17.1	18.1
Rye	6.5	10.5	9.2	10.6
Total	25.6	32.0	26.3	28.7
2. COARSE GRAINS:				
Barley	12.0	8.0	10.5	9.9
Oats	3.7	5.6	4.5	3.3
Maize	22.0	21.9	25.1	26.2
Total	37.7	35.5	40.1	39.4
Total 1 + 2	63.3	67.0	66.4	68.1
3. INDUSTRIAL CROPS:				
Sugar-beet	4.0	1.6	1.4	1.8
Hemp	0.2	0.0	0.0	0.2
Flax	0.1	0.4	0.3	0.4
Tobacco	0.1	0.2	0.0	0.1
Sunflower	0.5	0.5	0.5	0.7
Total	5.2	3.0	2.5	3.4
4. VEGETABLES:				
Tomato	0.0	0.0	0.1	0.1
Paprika	0.1	0.0	0.1	0.1
Cabbage	0.1	0.1	0.1	0.1
Green pea	0.1	0.1	0.1	0.2
Total	1.1	0.6	1.2	1.3
5. POTATO	6.0	8.9	7.5	7.4
6. ROUGHAGES AND SOFT FODDERS				
Roughages	13.7	12.8	13.4	10.7
Soft fodders	7.1	4.5	5.4	5.1
Total	20.8	17.3	18.8	15.8
7. OTHER	3.6	3.2	3.6	4.0
Total arable land	100.0	100.0	100.0	100.0

intensive insolation due to southern exposure, long, sunny autumns and, of course, the accumulated skill of many centuries of cellarage experience.

The distribution of the *main field crops* shows many similarities in every region (Table III). The low degree of specialization is indicated by the crop percentage of cereals similarly in all the regions, even where the conditions for cereals are obviously unfavourable. The self-sufficiency of the former small-peasants survives to a certain degree in the farmers' co-operatives in every region. They endeavour to produce cereals for their own needs and maize and barley as required for the pigs (which again are bred for self-sufficiency).

Although the farms show a more varied specialization than the regions themselves, the uniformity of production is promoted not only by the above tradition of self-sufficiency but by other factors, too. Under the current production conditions and methods, the physical agents have a rather important influence on the crop yield; the continuity of production would be adversely affected by an intensive and rapid introduction of specialization. The farmers' co-operatives have to make efforts to employ their manpower

5	6	7	8	9	10	11	12	13	14
19.4	21.5	19.8	16.9	23.8	23.9	24.9	12.5	16.1	25.2
2.0	0.7	2.4	8.8	2.8	2.4	1.9	21.6	13.7	0.2
21.4	22.2	22.2	25.7	26.6	26.3	26.8	34.1	29.8	25.4
9.2	12.8	10.1	10.3	15.1	14.4	9.5	7.1	3.3	9.8
2.0	3.0	1.9	1.5	4.0	2.1	1.9	1.8	1.6	2.9
33.7	31.6	35.0	30.5	18.0	25.7	27.9	32.6	24.9	33.3
44.9	47.4	47.0	42.3	37.1	42.2	39.3	41.5	29.8	46.0
66.3	69.6	69.2	68.0	63.7	68.5	66.1	75.6	59.6	71.4
2.0	1.8	2.1	1.8	1.3	2.3	3.4	1.1	2.0	4.6
0.4	0.4	1.0	0.0	0.1	0.3	0.5	0.1	0.1	1.0
0.4	0.2	0.1	—	—	—	0.0	—	—	0.0
0.0	0.1	0.3	0.1	0.2	0.2	0.5	0.1	1.6	0.1
2.8	1.2	1.8	0.2	0.4	1.6	2.0	0.9	5.2	1.4
5.8	3.9	5.5	2.4	2.3	4.6	6.7	2.5	9.2	5.7
0.1	0.0	0.2	1.6	0.1	0.4	0.2	0.9	0.0	0.1
0.1	0.1	1.3	0.4	0.0	0.1	0.1	0.8	0.0	0.4
0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.1
0.2	0.2	0.6	0.7	0.3	0.1	0.2	0.6	0.0	0.2
1.4	1.0	3.6	5.6	1.0	1.6	1.6	3.9	1.2	2.4
3.8	4.1	3.8	5.7	7.1	5.6	2.2	4.4	14.6	1.3
12.4	12.7	8.8	8.7	15.7	12.8	10.8	5.4	8.7	8.5
4.8	4.8	4.1	3.9	3.5	2.9	4.1	4.1	3.3	4.6
17.2	17.5	12.9	12.6	19.2	15.7	14.9	9.5	12.0	13.1
5.5	3.9	5.0	5.7	6.7	4.0	8.5	4.1	3.4	6.1
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

throughout the whole fiscal year; this too would be endangered by rapid specialization. Therefore, although multilateral production is an impediment to the increase of productivity, all the crop groups are being grown in every district in order to ensure full and continuous year-round employment of hands.

The high acreage production of grain crops, varying from 59.6 to 75.6%, and usually accounting for 2/3 of the total arable land, determines, in many cases, the possible line of specialization. During the past twenty years the acreage of grain crops has decreased: the bread grains suffered a material decline, while the course grains have shown some increase. This indicates that production in the Great Plain areas has turned from the growing of bread grains into a pig-breeding type. The grain corps produced no longer meet the needs of the country, since their production area has been reduced since 1935 by about 1 million hectares, to the benefit of more intensive cultures.

The acreage ratio of bread grains is high mainly in those areas (regions 2, 12) where wheat (Fig. 1) and rye are raised side by side, partly for climatic, but chiefly for pedological reasons. Of bread grains, it is wheat that predominates in most parts of the country (20% of total arable area); rye is considerable on sandy or acid soils only. Owing to the dry, hot summers of recent years—conditions which reduce the yield of rye — the acreage allotted to rye has rapidly decreased.

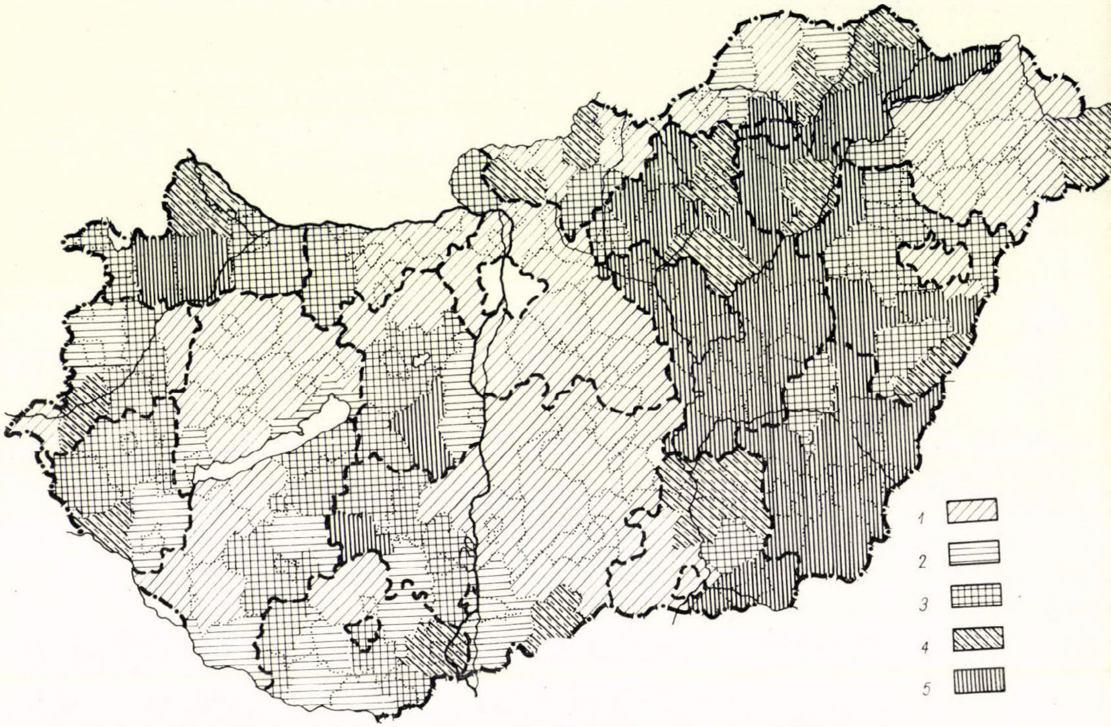


FIG. 1. Productivity of the growing areas of wheat compared with national average
1 = far below; 2 = below; 3 = about; 4 = above; 5 = high above

Substantially larger areas are given to *course grains* than to bread grains in almost every region. Of the fodder crops *maize* (Fig. 2) has the largest sowing area in Hungary. In its main growing areas its crop ratio exceeds 30%. In the regions along the Danube (nos 5, 6, 7) it is raised in part for the market; in the Great Plain centres (regions 11, 14) it provides a basis for the local specialization in pig and poultry rearing. Maize is grown to a lesser extent in the cool western and mountain regions, where the best varieties have not time enough to ripen because of the long growth period. Their ratio is low on the acid sand soils as well. The lower amount of maize in western Transdanubia is related to the composition of the livestock: the regions of western Transdanubia belong to the cattle-breeding types, and the pig stock is much smaller there than it is in the Great Plain. In Hungary, unlike the Balkans and Italy, maize is not used as food for humans.

Barley complements maize in many regions; it serves for foraging pigs. It is grown at the highest crop percentage where the ratio of maize is lower than the average. In regions 1, 10 and 9 malting barley has become a prevalent crop. After several decades' decline, the ratio of barley is rising again, as it can be grown with fairly constant results in produce, and by a simpler degree

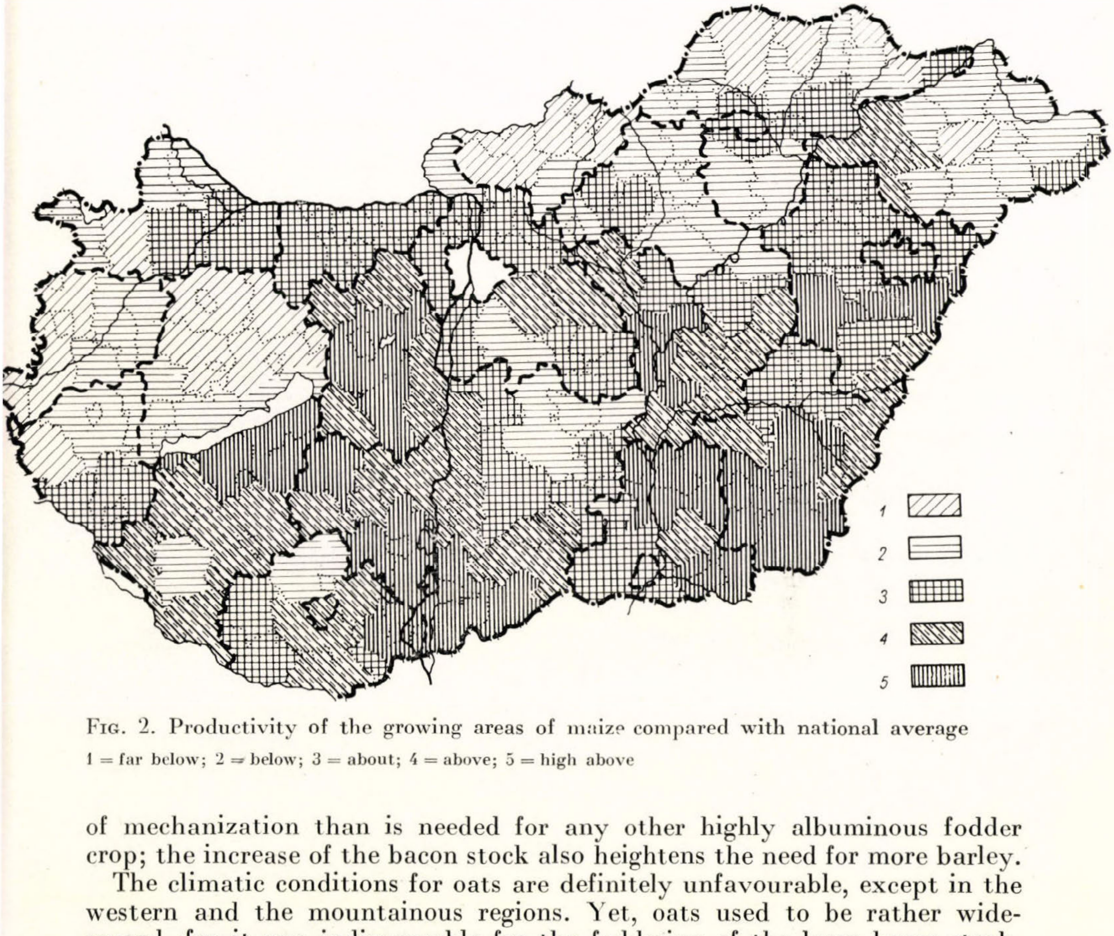


FIG. 2. Productivity of the growing areas of maize compared with national average
1 = far below; 2 = below; 3 = about; 4 = above; 5 = high above

of mechanization than is needed for any other highly albuminous fodder crop; the increase of the bacon stock also heightens the need for more barley.

The climatic conditions for oats are definitely unfavourable, except in the western and the mountainous regions. Yet, oats used to be rather widespread, for it was indispensable for the foddering of the large horse stock. However, owing to mass collectivization, both the growing of oats and breeding of horses have declined relatively quickly.

The *industrial cultures* vary between 2 to 5%. They showed a material increase after World War II. Today they meet the requirements of the processing industry, and therefore no considerable widening of their crop area is to be reckoned with for a while.

The most important industrial crop of Hungary, the sugar-beet (Fig. 3) is produced mainly in regions 1 and 14. The production of sunflowers for their oil shows great fluctuations. Before World War II, it was raised practically as a border crop. Shortages in animal fats, due to the war and its aftermath, made it the most important industrial crop. Since, however, Hungarian cooking is traditionally averse to using vegetable oil and insists on use of the traditional lard, the production of sunflower oil has been reduced simul-

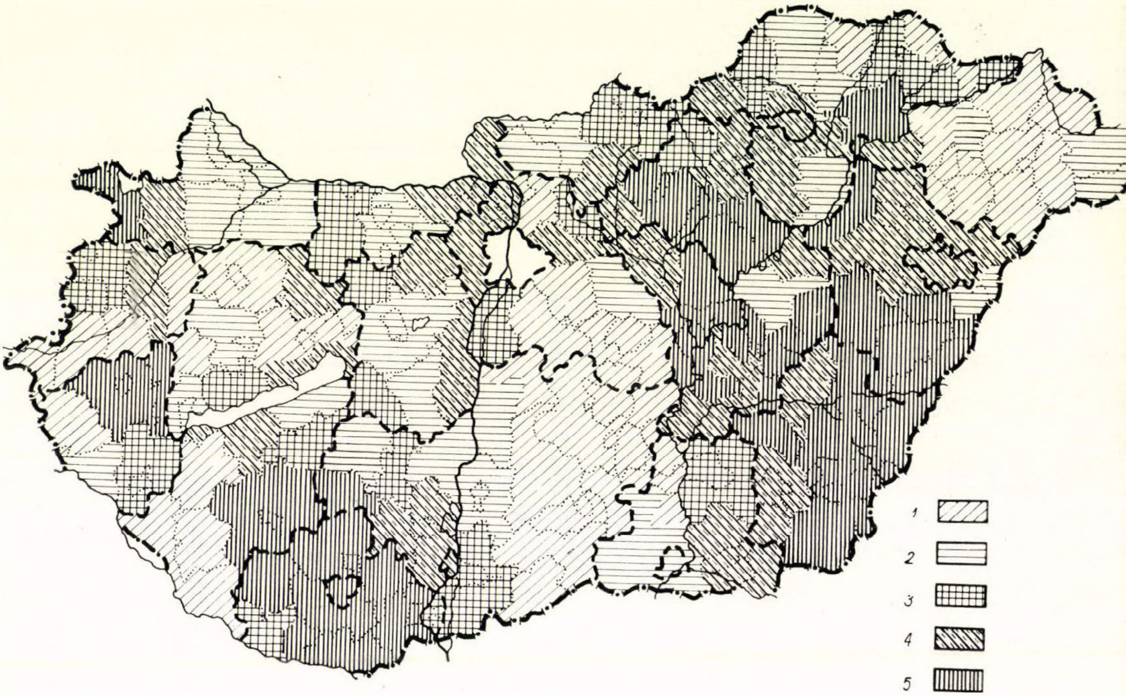


FIG. 3. Productivity of the growing areas of sugar-beet compared with national average
1 = far below; 2 = below; 3 = about; 4 = above; 5 = high above

taneously with the post-war revival of pig-breeding, and it is only the advantageous export demand that keeps the current production of vegetable cooking-oil at a fair level.

Considerable *vegetable* (Fig. 4) raising areas are to be found only in the central part of the country (regions 7, 8 and 12). Nevertheless, the volume of export of fresh and canned vegetables is worth mentioning. The high number of sunny hours resulting from the basin character of Hungary is very favourable for vegetable-growing, particularly as regards flavour, colour and vitamin content. An expansion of production is expected to take place in the near future in the regions bordering the actual centre of the country from the east and the north; the CMEA market offers good possibilities for expanding sales.

Potatoes, (Fig. 5) a favourite food in Hungary, are grown on a considerable area in every region, but the crop yield is usually low, owing to the strong exposure to drought. As the soils and climatic conditions in regions 2 and 13 are more favourable for this crop, the bulk of production ought to be shifted to these areas. As it happens, in these two regions 10 to 15% of the crop is used for foraging herds.

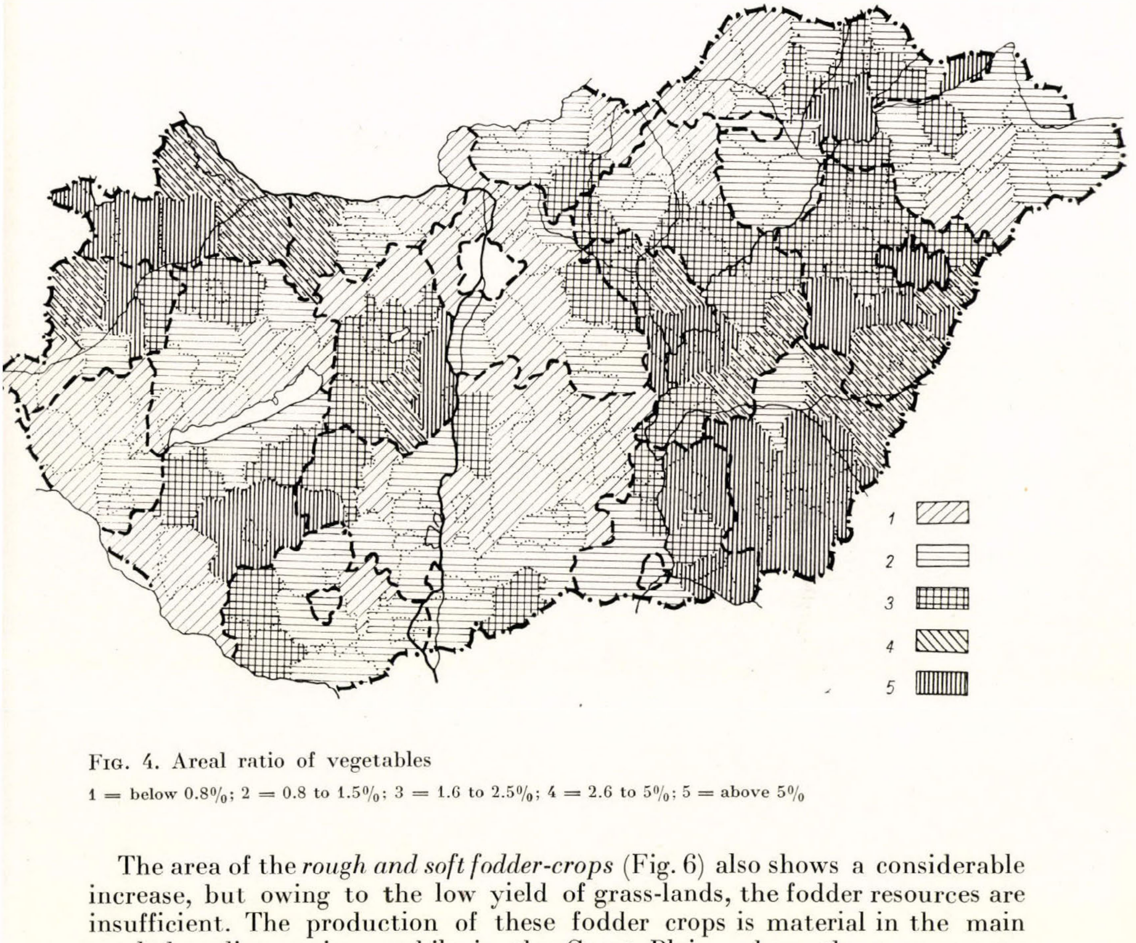


FIG. 4. Areal ratio of vegetables
1 = below 0.8%; 2 = 0.8 to 1.5%; 3 = 1.6 to 2.5%; 4 = 2.6 to 5%; 5 = above 5%

The area of the *rough and soft fodder-crops* (Fig. 6) also shows a considerable increase, but owing to the low yield of grass-lands, the fodder resources are insufficient. The production of these fodder crops is material in the main cattle-breeding regions, while in the Great Plain, where the summers are dry, it usually fails to meet the needs of the scanty cattle stock.

Of this plant group, lucerne is most widespread as it is the most drought resistant. It should be noted that the less favourable the climatic conditions are for hay, the more favourable they are for growing seeds of fodder plants, particularly of leguminous ones. The markets for their exportation are good, too.

In Hungary, crop farming on arable land shows a widely varied pattern. The plants characteristic of Atlantic Europe (rye, oats, potato) are favoured, as well as those of the warm continental zones (wheat, maize, sugar-beet), but subtropical crops (rice, paprika, ricinus) and even tropical ones (arachis) are also common. This great variety is mainly due to the growing season being uncommonly long and warm for this latitude; but it is also a survival of small-peasant farming.

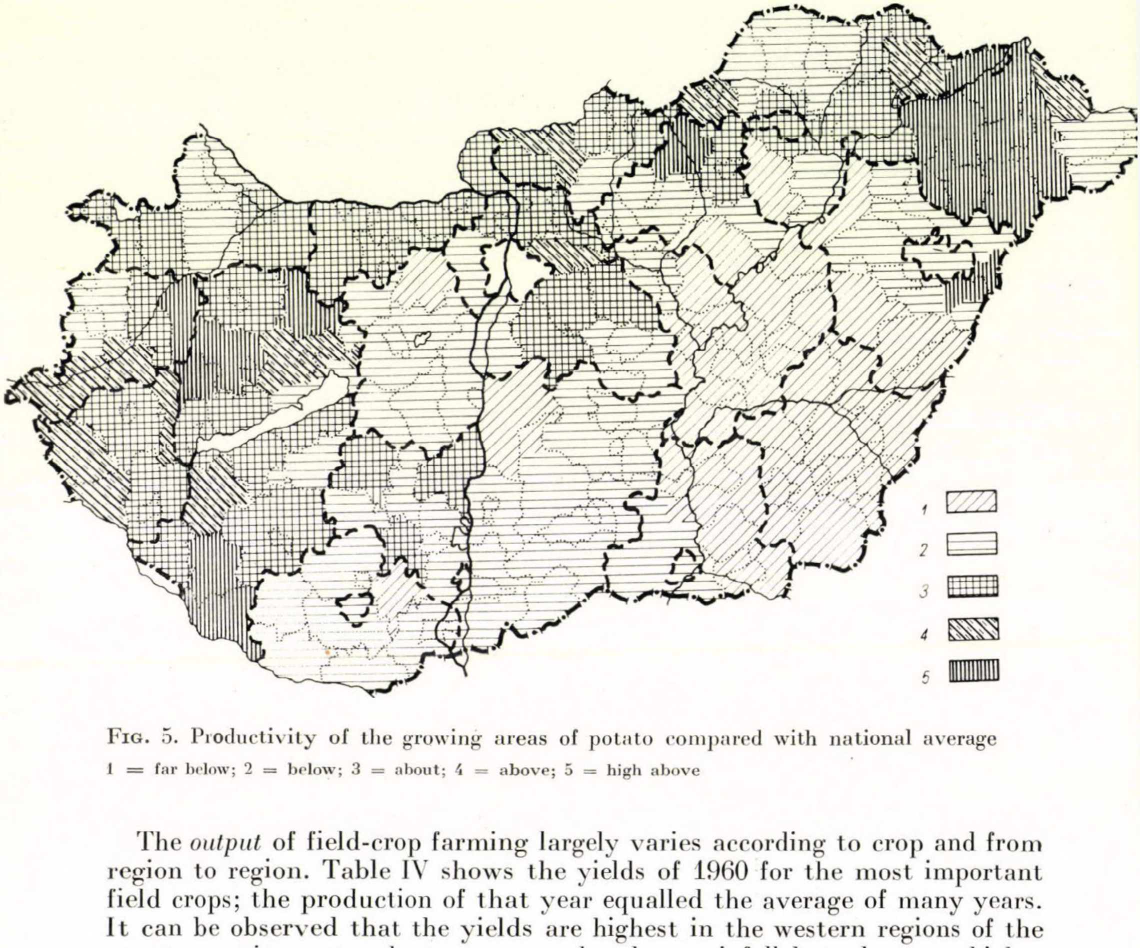


FIG. 5. Productivity of the growing areas of potato compared with national average
1 = far below; 2 = below; 3 = about; 4 = above; 5 = high above

The *output* of field-crop farming largely varies according to crop and from region to region. Table IV shows the yields of 1960 for the most important field crops; the production of that year equalled the average of many years. It can be observed that the yields are highest in the western regions of the country, owing not only to a more abundant rainfall but also to a higher level of farming skill. In the central and southern areas of the Great Plain (regions 11, 14), which are poorest in precipitations, the crop yields—excepting a few plants requiring much moisture—are at least average. In these regions the shortage of rainfall is partly compensated by the great fertility of the chernozem soils. The lowest yields are recorded in the Central Mountains of North Hungary and on the Sand Ridge of the Danube—Tisza Midregion. An inappropriate system of production resulting from self-sufficiency tendencies is mostly responsible for this. In the northern Highland where the physical conditions are obviously unfavourable for growing grain crops, the crop ratio of bread grains is not any lower than it is in the Great Plain. However, the same conditions, which are very good for the roughages, could be better utilized by growing more rough-fodder crops, even at the expense

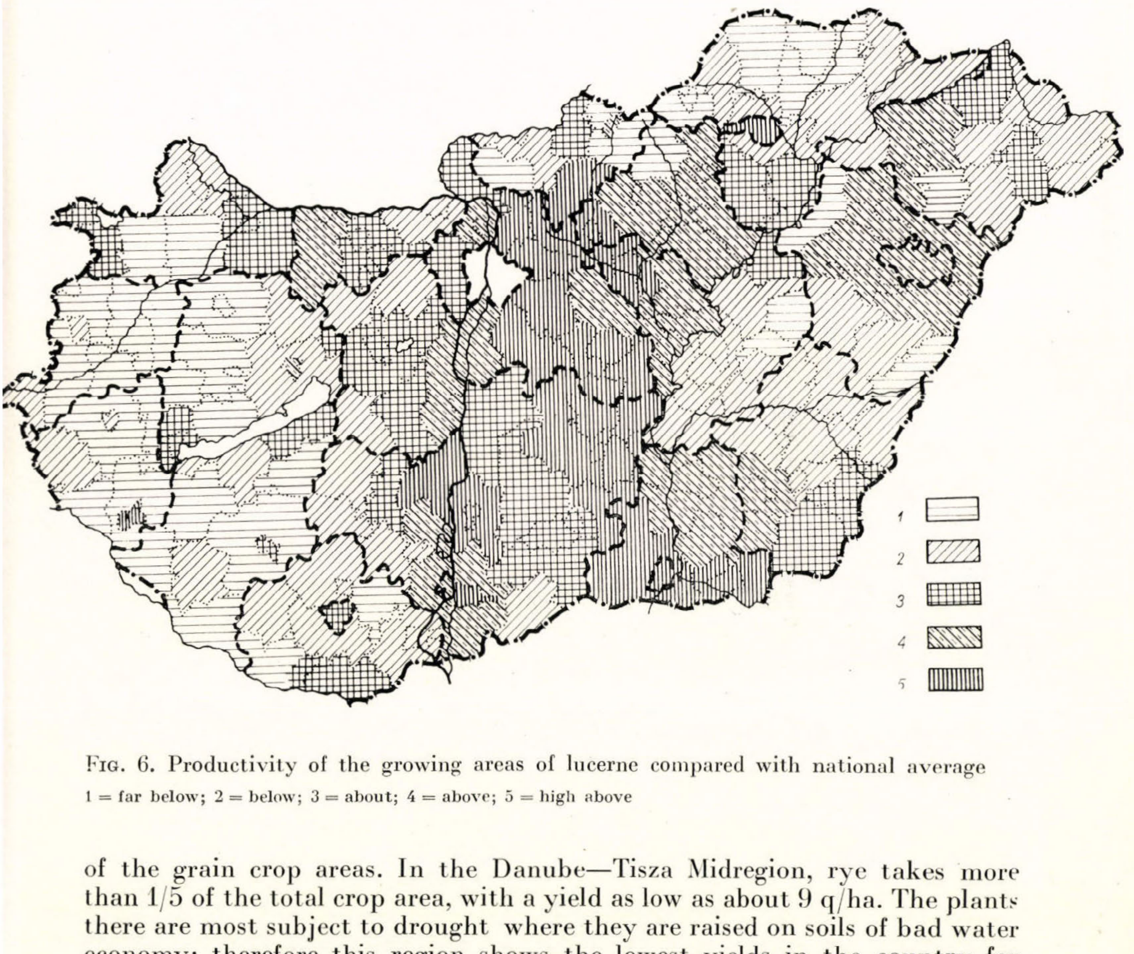


FIG. 6. Productivity of the growing areas of lucerne compared with national average
1 = far below; 2 = below; 3 = about; 4 = above; 5 = high above

of the grain crop areas. In the Danube—Tisza Midregion, rye takes more than 1/5 of the total crop area, with a yield as low as about 9 q/ha. The plants there are most subject to drought where they are raised on soils of bad water economy; therefore this region shows the lowest yields in the country for most plants. At the same time, the conditions there for all branches of horticulture are outstanding, even on an international scale. For this reason, the maintenance of the current extent of field-crop farming appears to be impractical. The same holds true for region 8, too: in this zone, which produces for the Budapest market, large-scale grain-growing is unreasonable.

In several regions the low yields of potato also raise doubts as to the lucrativeness of its production. On the calcareous, dry, sandy soils (one could hardly imagine worse conditions for potato) in regions 8 and 12, it accounts

Table IV

Yields of the principal field crops (q/ha, 1960)

Regions	Wheat	Rye	Winter barley	Spring barley	Oats	Maize*	Sugar-beet	Hemp**	Sun-flower	Potato	Rough-ages***
1. Little Plain	17.6	10.2	16.4	21.5	17.0	27.6	269	34.9	10.2	118	31.6
2. South-West Transdanubia	14.9	10.0	18.2	18.4	16.3	27.4	263	31.9	10.3	136	35.6
3. Transdanubian Central Mountains	14.4	11.6	14.8	18.2	13.9	27.4	256	54.9	8.7	93	26.7
4. Balaton Region	14.9	11.8	15.1	18.7	14.9	26.3	257	37.1	10.3	122	29.0
5. Mezőföld	15.8	12.2	18.6	18.2	13.8	25.5	240	37.6	10.3	121	19.0
6. South-East Transdanubia	15.1	10.2	17.7	16.2	14.5	26.1	261	31.1	10.0	107	24.6
7. Danube Valley	16.5	12.1	19.4	17.3	18.0	22.1	236	36.6	10.1	97	17.7
8. Surroundings of Budapest	14.9	10.9	15.9	18.0	11.9	21.4	205	17.0	7.2	65	16.3
9. Central Mountains of North Hungary	12.1	9.7	11.9	15.1	10.0	22.6	228	25.6	7.8	112	27.6
10. Foreland of the Central Mountains of North Hungary	13.1	11.9	16.3	16.5	13.1	24.9	206	32.1	10.6	98	24.4
11. Tisza Region	15.6	10.7	19.4	17.9	10.7	23.6	241	40.5	12.4	94	16.7
12. Danube—Tisza Midregion	14.5	9.2	22.1	14.8	11.7	15.3	199	29.4	4.3	58	21.4
13. Nyírség and Szatmár-Bereg Plain	14.9	12.9	17.7	17.3	13.3	21.2	235	37.5	7.8	97	38.4
14. South-East Great Plain	15.7	10.7	20.2	18.9	13.6	22.4	218	41.0	10.9	67	25.6

* In terms of the moisture percentage in May
** Fibre
*** In hay units

for 4 to 6% of the total crop area, though its average yield is only 60 to 70 q/ha.

These casual observations indicate that the agriculture based on large-scale farming must, by all means, modify its current system of production. An inverse ratio is frequently found between the size of the crop area and the yields. In order to demonstrate this, the ratios of crop-percentage orders versus the yield orders of the respective regions are presented in Table V. (This problem has already been treated more fully on the scale of municipal districts.) In this very simple method the crop-percentage orders of the regions have been divided by their yield orders. If the value of the ratio is about 1, the crop area and the yield are commensurate (e.g. low yield, small areal proportion); if it is 2 or more, a high yield is shown against a low rate of crop area; and if it is 0.8 or less, the respective crop is raised on a large area with a low yield.

What has been stated above is also evidenced by Table V. For example: in the mountainous region 9, most of the cereals give a very low yield; the potato areas ought to be reduced in the sands of the Great Plain, while they should be extended in the acid and rainy sands of Transdanubia, etc. At they same time, the maize-growing areas can be regarded as properly distributed: maize yields a satisfactory crop in the western regions, so no considerable increase of its actual area is required. In the Sand Ridge of the Danube—Tisza Midregion the maize is produced extensively to compensate for lack of other fodder crops, which again would not be any better if grown there. However, it would be worth while replacing it, at least in part, by broomcorn varieties acclimatized to sand soils.

All the branches of domestic crop-farming have been discussed under the land utilization forms, with the exception of *fruit-production*, which cannot be linked up with any form of land utilization in Hungary. A few decades ago fruit was grown almost exclusively for self-sufficiency; fruit-trees had been planted in household gardens, in vineyards, sporadically on arable lands, along the roads, etc. Specialized orchards on a commercial scale were developed only between the two wars, but have never been really successful. After World War II large marketing orchards were set up on state farms, and more recently by farmers' co-operatives; and since 1960 (by the recommendation of the CMEA) a very extensive planting has been undertaken. The fruit-tree stock was measured last in 1959, when only 9% of total fell to commercial orchards. At present, their estimated proportion is 12 to 15%, which, however, may vary according to the species of fruit. Winter-apple, for instance, the most important export fruit of Hungary, amounts to 40%. In the main centre of winter-apple production, notably in region 13, the ratio of the commercial orchards is three times higher than the national average. The fruit-tree stock is prominent in regions 8 and 12: these two regions have fully 1/4 of the national total of 87 million trees. A considerable number of the fruit-trees are grown in vineyards (Table VI).

Plum, as requiring the least tending, is the most widespread of all the fruit species. Apple, peach and apricot are most important for both domestic market and for exports. By the time the recent plantings become productive, Hungary may become one of the most important fruit-exporting countries

TABLE V

Ratios of crop-percentage orders versus yield orders of the regions

Regions	Wheat	Rye	Winter barley	Spring barley	Oats	Maize	Sugar-beet	Potato	Rough-ages
1. Little Plain	9	0.7	1.33	3	2	12	2	1.5	0.67
2. South-West Transdanubia	0.85	0.33	0.83	3	0.33	6.5	5.5	2	2
3. Transdanubian Central Mountains	0.91	0.83	0.77	0.8	0.33	3.33	2.4	0.27	0.5
4. Balaton Region	1.2	0.6	0.66	2	1.2	2	2	2	2.2
5. Mezőföld	2.6	5.5	0.6	1·5	1.2	0.3	0.85	3.6	0.63
6. South-East Transdanubia	0.83	1.2	0.14	0.83	1.2	1	3	1.6	0.75
7. Danube Valley	3.5	3	0.67	1.2	10	0.09	0.62	1.5	0.83
8. Surroundings of Budapest	1.3	0.85	0.36	1	1.2	0.5	0.77	0.53	0.78
9. Central Mountains of North Hungary	0.28	0.61	1	0.08	0.22	1.5	1.3	1	0.2
10. Foreland of the Central Mountains of North Hungary	0.23	2.5	1.3	0.18	0.8	1.2	0.33	1.1	0.55
11. Tisza Region	0.4	1.5	2.2	0.62	0.85	0.88	0.5	1.3	0.62
12. Danube—Tisza Midregion	1.2	0.07	7	0.92	1	0.28	1	0.64	1.4
13. Nyírség and Szatmár-Bereg Plain	1.3	2	1.37	1.4	1.44	0.85	0.77	0.11	12
14. South-East Great Plain	0.25	1.55	3.0	4	0.88	0.3	0.09	1.1	1.8

TABLE VI

Structure of the fruit-tree stock in 1959 (%)

Regions	Apple	Pear	Cherry	Morello	Plum	Apricot	Peach	Other	Total	Ratio of the commercial orchards
1. Little Plain	14.8	9.2	5.8	4.1	37.8	5.2	9.6	13.5	100.0	8.4
2. South-West Transdanubia	19.2	8.6	4.2	4.1	36.7	2.7	11.5	13.0	100.0	6.2
3. Transdanubian Central Mountains	11.0	8.2	5.3	5.8	35.3	5.0	16.7	12.7	100.0	5.1
4. Balaton Region	10.7	8.5	4.7	5.4	30.4	6.4	14.7	19.2	100.0	6.5
5. Mezőföld	9.3	5.9	5.4	9.9	28.7	9.5	14.7	16.6	100.0	9.7
6. South-East Transdanubia	8.0	5.0	3.9	9.7	39.1	4.4	17.5	12.4	100.0	7.8
7. Danube Valley	14.2	4.5	3.8	13.8	28.2	10.0	12.9	12.6	100.0	11.5
8. Surroundings of Budapest	10.3	6.0	6.0	8.9	28.1	9.1	20.4	11.2	100.0	9.2
9. Central Mountains of North Hungary	11.4	5.7	5.7	2.9	57.3	2.5	6.0	8.5	100.0	5.8
10. Foreland of the Central Mountains of North Hungary	13.1	6.8	8.8	4.0	41.8	6.3	9.0	10.2	100.0	6.8
11. Tisza Region	12.1	4.6	3.6	12.2	44.6	6.1	7.0	9.8	100.0	7.2
12. Danube—Tisza Midregion	21.1	5.0	2.9	15.7	21.0	13.3	16.3	0.2	100.0	7.3
13. Nyírség and Szatmár-Bereg Plain	37.4	2.9	2.3	8.8	33.6	2.5	5.0	7.5	100.0	28.4
14. South-East Great Plain	14.9	5.8	3.2	15.0	43.5	5.5	2.4	9.7	100.0	9.3

in Europe. Every region is suitable for fruit-growing, and so are those mountainous and sandy areas where — as has already been stated — the yields of field crops are low anyway. Fruit production in these regions might develop so as to become one of the principal contributors to economic prosperity.

The wide range of natural and artificial fodder resources, as listed above, makes it evident that pig- and poultry- breeding, and *cereals* and maize for consumption, are the most significant elements in *stock-farming*, whereas cattle-breeding is more subordinate in Hungary than it is in western Europe.

The traditional method for estimating the composition of livestock uses animal units. (In Hungary one animal unit = 500 kg live weight; according to the average computed by age and sex: 1 cattle = 1 animal unit, 1 horse = = 0.8, 1 pig = 0.116 and 1 sheep = 0.05.) An analysis of the composition of the livestock by animal units provides only very general information, because it does not figure with the differences in yield, and over-estimates the horse stock, etc. Nevertheless, fairly reliable data can be obtained by it as to the ratios of the individual animal species in the various regions.

TABLE VII

The composition of the livestock shown in animal units

Regions	Cattle	Pig	Horse	Sheep	Total
1. Little Plain	70.6	15.8	12.0	1.6	100
2. South-West Transdanubia	69.2	14.8	15.0	1.0	100
3. Transdanubian Central Mountains	69.8	14.8	12.5	2.9	100
4. Balaton Region	64.1	16.9	14.7	4.3	100
5. Mezőföld	48.4	26.0	20.7	4.9	100
6. South-East Transdanubia	54.1	23.2	19.3	3.4	100
7. Danube Valley	40.6	27.2	25.4	6.8	100
8. Surroundings of Budapest	50.5	25.6	20.7	3.2	100
9. Central Mountains of North Hungary	65.9	13.5	15.4	5.2	100
10. Foreland of the Central Mountains of North Hungary	65.8	14.9	16.5	2.8	100
11. Tisza Region	51.3	25.4	15.3	8.0	100
12. Danube—Tisza Midregion	43.9	24.7	26.6	4.8	100
13. Nyírség and Szatmár-Bereg Plain	60.7	19.2	15.2	4.9	100
14. South-West Great Plain	51.6	35.9	8.8	3.7	100

Cattle-holding (Fig. 7) appears to be important in the regions of western Transdanubia, in the mountainous regions and in the Nyírség. It does not have the definite character of a dairy economy in either of the regions (the ratio of milking cows averaging 45%); cattle are bred for both milk and beef production. The most widespread bovine variety, the so-called Hungarian mottled cross-breed, has also been bred for mixed utilization. Owing to difficulties in foraging, the milk yield is low (2300 litres per year); and yet among the CMEA nations it is only in the German Democratic Republic that the yields are better. In regions 1 and 2, the cattle-breeding is kept at a fairly high level, the fodder resources being also favourable there. In region 13, the stock is considerable but has no material yield, since cattle there are used as draught animals on the loose sandy soils.

Pig-holding (Fig. 8) is most important in the eastern Transdanubia and in the Trans-Tisza Region, i.e. in the chief maize belts. It is noteworthy that the total number of pigs exceeds that of cattle by three times (6 million against

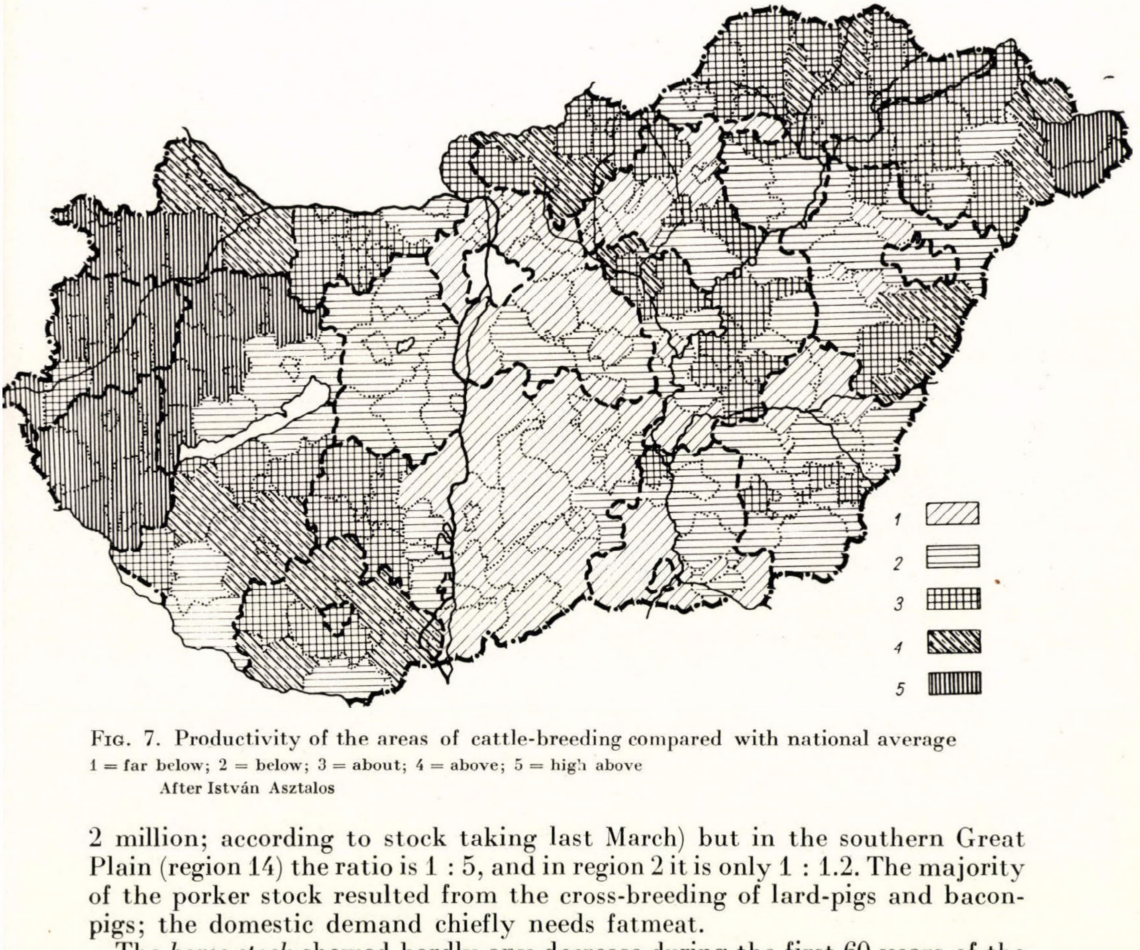


FIG. 7. Productivity of the areas of cattle-breeding compared with national average
1 = far below; 2 = below; 3 = about; 4 = above; 5 = high above
After István Asztalos

2 million; according to stock taking last March) but in the southern Great Plain (region 14) the ratio is 1 : 5, and in region 2 it is only 1 : 1.2. The majority of the porker stock resulted from the cross-breeding of lard-pigs and bacon-pigs; the domestic demand chiefly needs fatmeat.

The *horse stock* showed hardly any decrease during the first 60 years of the 20th century (disregarding a temporary decrease during the war-years), as the mechanization of agriculture made slow progress. The number of horses was almost half of that of the cattle stock even ten years ago. This was partly due to the settlement system peculiar to the Great Plain (lack of good roads, scattered farmsteads for the population for which horses used to provide transport facilities) and also to a traditional favouring of horses. Owing to mass collectivization, and agricultural mechanization, since 1960, the horse stock has rapidly decreased. However, the distribution of the stock still appears to be influenced by the particular topography and by the scattered farmstead-settlement.

In the first half of the 19th century *sheep-breeding* was one of the most important factors in Hungarian rural economy, but later on it could not avoid the quick decline that occurred throughout Europe. Since World War II

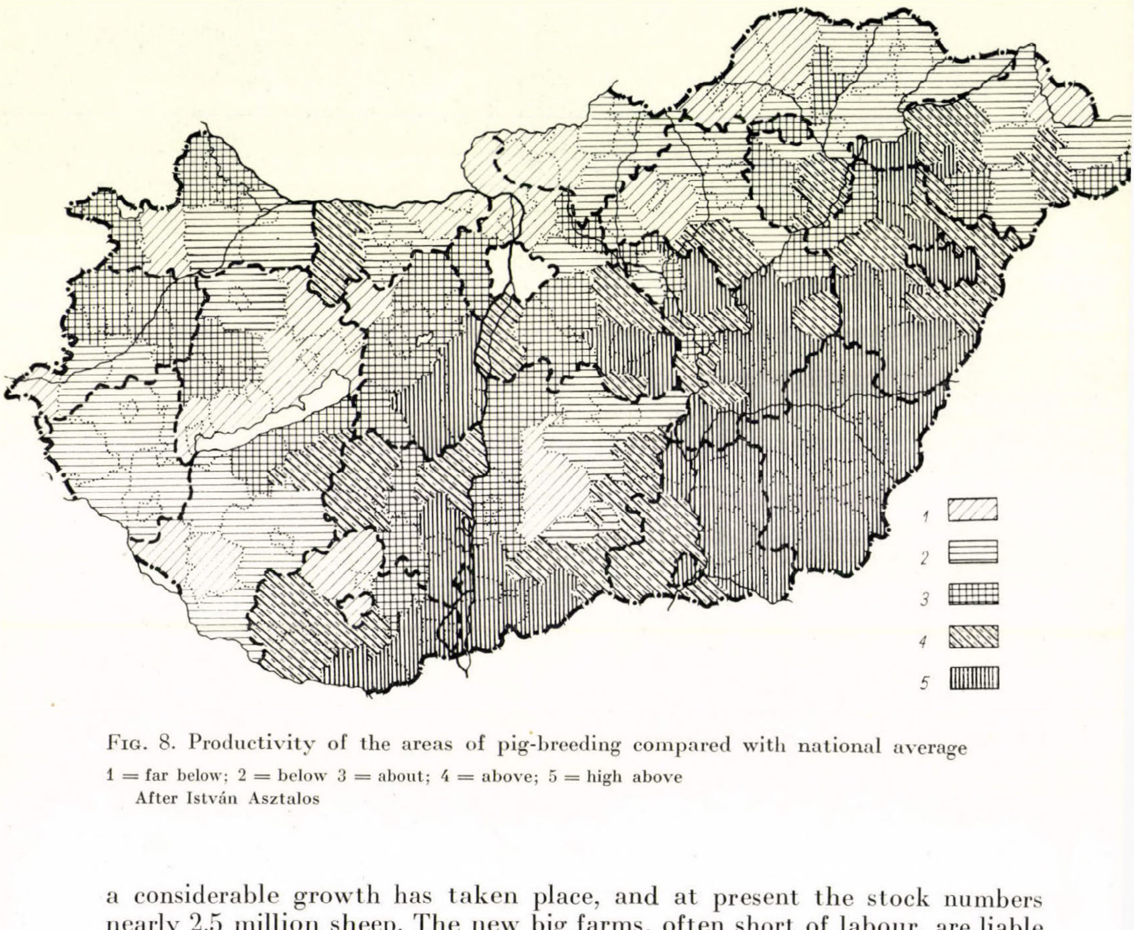


FIG. 8. Productivity of the areas of pig-breeding compared with national average
1 = far below; 2 = below 3 = about; 4 = above; 5 = high above
After István Asztalos

a considerable growth has taken place, and at present the stock numbers nearly 2.5 million sheep. The new big farms, often short of labour, are liable to utilize their grasslands by sheep-grazing, which requires the least possible manpower. This sheep-grazing is distributed everywhere there are pastures of sandy or sziksoils of low grass yield.

Poultry-farming plays an important role in the animal husbandry of Hungary. The value of its yield is slightly inferior to that of cattle-breeding, and in some regions it makes up one of the main characteristics of production (region 14). The areal distribution of total stock shows no great variety, as even non-agricultural labourers (apart from the big towns) raise poultry for self-sufficiency. Its production is conducted on a commercial scale in regions 12 and 14. The traditional extensive poultry-farming could be developed in the scattered farmsteads' system, under the conditions of which the waste of field-crop could be utilized by poultry. In recent years the number of modern, intensive broiler- and egg-farms has been increased, and considerable amounts of slaughtered poultry are exported from Hungary.

Most branches of stock-farming are focused on meat production. Therefore, Hungary's annual meat production per capita is by far the highest (86 kg) among the CMEA nations and is sufficient to permit considerable export.

The density of the main live-stocks in the agricultural areas is shown in Table VIII.

TABLE VIII

Density of livestocks per 100 ha of agricultural land

Regions	Cattle	Pig	Horse	Sheep	Poultry
1. Little Plain	38.2	65.0	7.3	10.3	462
2. South-West Transdanubia	42.6	64.0	8.8	6.6	450
3. Transdanubian Central Mountains	33.1	49.4	5.9	15.1	430
4. Balaton Region	30.2	51.9	6.9	18.2	452
5. Mezőföld	22.0	82.5	9.3	24.5	464
6. South-East Transdanubia	26.7	89.1	10.2	21.3	470
7. Danube Valley	17.4	81.8	10.4	32.5	381
8. Surroundings of Budapest	11.7	41.7	4.8	8.3	272
9. Central Mountains of North Hungary	34.5	49.3	8.0	30.5	361
10. Foreland of the Central Mountains of North Hungary	33.0	52.2	8.3	15.8	389
11. Tisza Region	23.6	82.1	7.0	41.2	384
12. Danube—Tisza Midregion	18.4	72.5	10.5	21.9	346
13. Nyírség and Szatmár-Bereg Plain	36.9	82.6	9.3	33.7	445
14. South-West Great Plain	23.2	114.0	3.9	18.3	502

The characteristics of the individual branches of agricultural production have been set forth in the above table, for all the regions. In the following, we intend to present the characteristics of each region.

Characterization of the individual agricultural regions

(1) *The Little Plain*, a Pliocene-Pleistocene depression, is situated in the north-western part of the country. Its flat surface is of a lowland character, and is substrated by the huge alluvial fan of the Danube. Unlike in the Great Plain, loess formation has played no significant role in its morphogenesis. So the dusts deposited on the western edges, because of the rather cool and wet climate, resulted in the formation of glacial loams instead of loesses.

The climate of the region is continental, but it also shows many oceanic features, so it is altogether more balanced than that of the Great Plain. The amount of heat and insolation is relatively low, inadequate for crops requiring much heat. (In the growing season the amount of heat ranges from 2900 to 3100 °C, with an increase to the east.) Bad frosts are frequent in the early spring and early autumn. The rainfall is but a little higher than in the Great Plain, but is much more regular, so droughts seldom endanger the crop.

Its hydrography is good, great stores of groundwater are supplied. However, owing perhaps to the regular distribution of rainfall, land irrigation has been neglected, though it would considerably increase the yields of grasslands and pastures.

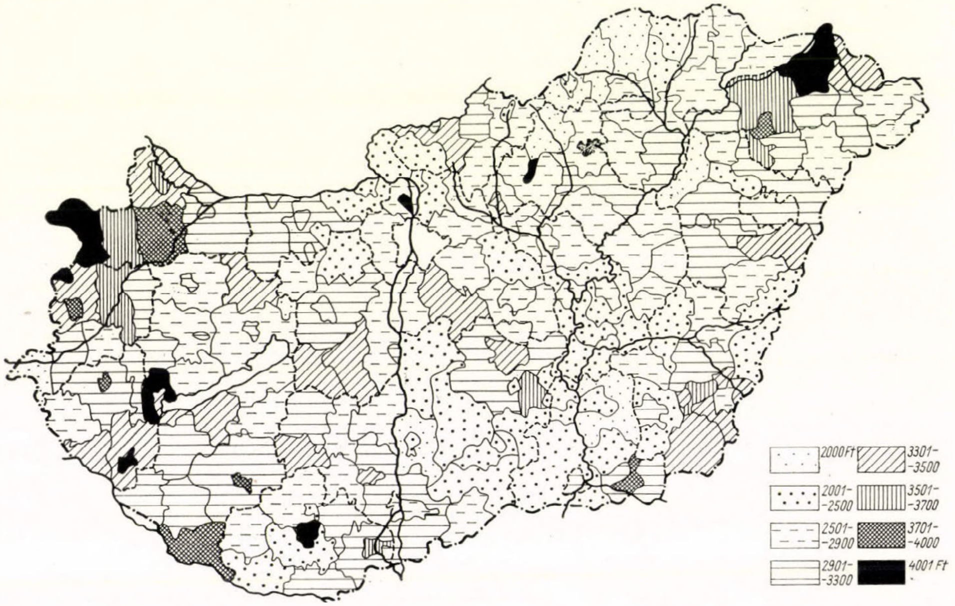


FIG. 9. The level of agricultural production (in terms of production value per 1 cadastral yoke)

After László Simon

Soil-geography exhibits a varied pattern here. The vast central area is covered by the fertile floodplain soils of the Danube and the Rába. These soils, like the loessy ones in the eastern zone, show a chernozem character. The soils in the western marginal zone are lower in quality. The peaty soils in the north-west, in the area of the former Hanság Swamp, are suitable only for certain crops, and the risk of deflation is also great. The mountainous landscape, bordering the Little Plain from the west (Subalpine Region) may be characterized by a bleached forest soil (podsol) with an acid reaction, a bad water regime. It has been largely eroded.

The fertile soils of the level surface are favourable for field-crop farming. The climate, relatively cool and with abundant precipitation, reduces the risks of yield fluctuation, and favours grass and rough fodder crops, but precludes some plants which require high heat.

The agriculture in general displays a standard largely exceeding the national average, and may be classified as cattle-breeding type. The high level of production is due to a favourable historical evolution, for field-crop farming was first developed here in Hungary. The region did not suffer from the Turkish rule in the 16th and 17th centuries, so capitalistic production could be started here quite early. Whereas the latifundia in the Great Plain had preserved many feudalistic features until as late as the eve of World War II, the farms in the Little Plain could keep level with the Central-European (Austro-German) development. In addition, the small-peasant holdings had not been parcelled out to such an extent as they had been in the Great Plain; the considerable industry in the region, absorbing the surplus of agricultural labour, contributed much to this. Since the peasants here had never been averse to modern techniques, the reorganization of agriculture was completed first in this region, in 1960.

The cattle-breeding was developed on the basis of local conditions favourable for fodder production. Both grass (meadows) and roughage (lucerne, red clover) give an abundant yield. Cattle are chiefly bred for dairy farming (this is unique in the country), which brings about an important milk-processing industry and a developed bacon-farming. Animal husbandry plays a prominent role both in the structure of production value and in market production.

In crop-farming, which is not insignificant, we may lay stress on the industrial crops, especially sugar-beet and some special cultures, such as chicory, raised only here in Hungary. The bulk of barley is utilized as an industrial crop (malting barley).

The future of the region, however, calls for a still more intensive cattle-breeding. This raises many problems, because raising cattle at prevailing costs of the fodder results in an inadequate yield in dairy produce (which seems to be high only in relation to the national average). Since the economic conditions for beef production are good, sometimes the brood animals are fattened and slaughtered.

(2) *South-West Transdanubia* is characteristically a rolling country. In its northern part the gravel sheet of the river Rába is exposed, but the greatest part of the region is covered by spots of glacial loams and Pannonian loose, sandy-clayey sediments.

Long, straight, parallel, meridional valleys formed between the rivers Zala and Mura are responsible for the peculiar physiognomy of the relief. They cut up the surface into ridges of low elevation.

As to the climate, this region of Hungary is the most abundant in rainfall; the Atlantic influence is most pronounced. The fluctuation of the mean annual temperature is moderate. The annual precipitations vary from 800 to 1000 mm. The climatic conditions offer possibilities for subalpine farming. The surface drainage shows a dense network arrangement.

Its soils are mostly acid and not of good quality. On the ridges, podsolic brown forest soils have been formed, but such ones in the eastern zone are less leached. In the valleys there lie meadow and boggy soils. On the slopes bordering the valleys the soil erosion is very active, owing to abundant precipitation.

The gentle hill-sides are utilized as arable lands, though to a smaller extent than that of the plain regions. The waterlogged bottoms of the valleys are generally covered by meadows. Hill pastures are also common.

Field crops requiring much heat are precluded, and also the plants preferring calcareous soils. At the same time, the conditions are excellent for producing roughages.

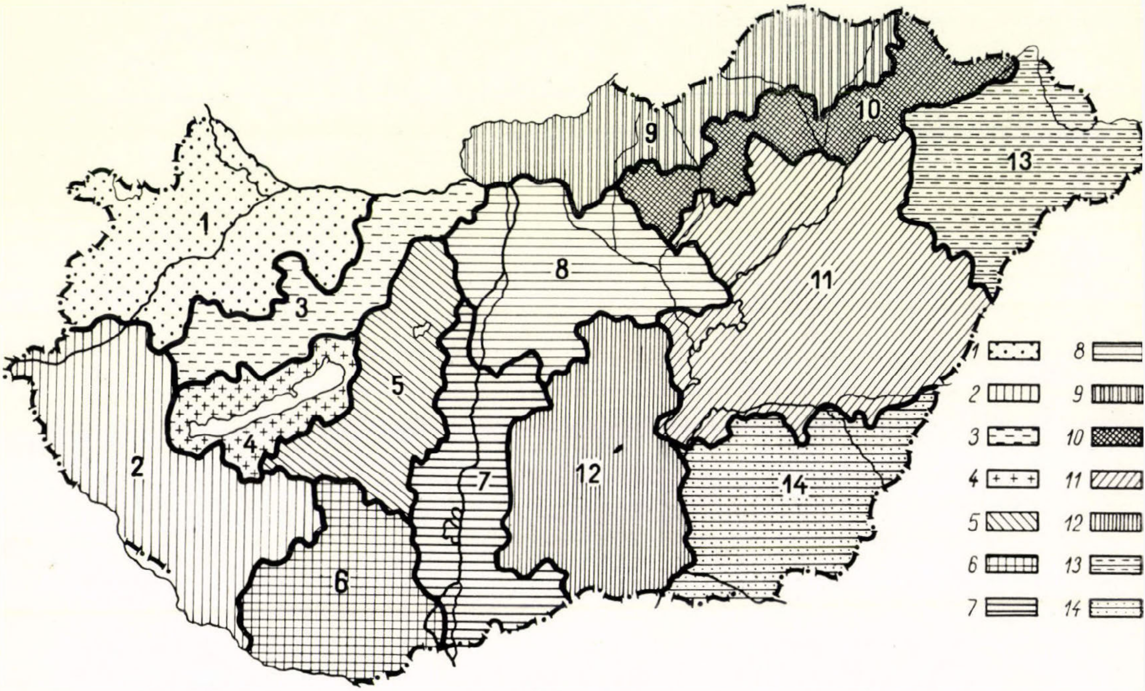


FIG. 10. Geographical types of the Hungarian agriculture

The type of production is fundamentally cattle-breeding, but it differs in many respects from that of region 1.

The role of pastures in cattle-breeding is more important here than in any other region of the country. These pastures, which extend in gentle slopes abundant in rainfall, give yields enough for cattle-farming, which is of a mixed type: beef-production and dairying; and although the latter contributes fairly well to the national total considering the number of cows, its standard is lower than in region 1. The ratio of cattle to pigs is the highest here, but the pig stock is also considerable.

The structure of crop-farming is also different from that of region 1. Markedly high is the ratio of bread grains; wheat is raised in equal quantity with rye. In the roughage crop, lucerne is replaced by red clover. The bread grains and fodder crops account for 85% of the total crop area. Among the other plants, only the potato produce is worthy of mention.

In the zone close to Lake Balaton, a commercial fruit-producing area is being developed.

The production type must be further developed along lines of cattle-breeding. The bread grains need not necessarily be grown at the present rate. The soils should be improved over large areas. With a view to overcoming erosion, it would be practical to turn into pastures those arable lands lying on slopes, which are of poor quality anyway. The conditions are rather good for developing the production of late-ripening winter apples. The crop area of potato should also be enlarged in order to disburden other regions.

Fairly extended vine areas are cultivated for self-sufficiency. As most of the wines produced are of a very low quality, the vine areas will most likely be reduced.

(3) *The Transdanubian Central Mountains* made up mainly of Mesozoic rocks, stretch from the southwest to the north-east, separating the Little Plain and the Great Plain from one another. The individual blocks of the range are severed by wide transverse valleys and fault troughs.

Although the region is well rained upon, the surface drainage is scarce, because the limestones of the mountains absorb a great deal of water.

The landscape used to be entirely covered by forests (which now account for about 50% of the area), so forest soils represent the predominant soil type here. They mostly have a thin and very poor fertile layer, and they are intensively eroded.

In this region (which is one of the most important mining districts of the country, also having the only deposits of bauxite and manganese ores in Hungary) agriculture is a subsidiary branch. Owing to rapid industrialization, the populace shows a transition-structure; the majority of the males are non-agricultural breadwinners; mostly the females or aged males are engaged in the co-operative farms, so their income derives from double economy. The agricultural manpower is of limited value, which influences the level and structure of rural production for the worse.

Little of the surface of the gentle slopes can be utilized by agriculture, which is conducted mostly in the agrarian "isles" formed in basins, valleys and at mountain feet. Quite a number of farms are run for self-sufficiency by the half-miner or part-time worker families; considerable quantities of maize are grown, mostly utilized as fodder for pigs fattened by the non-agricultural population. The part-time farmers sow cash crop only occasionally: hardly any industrial crops — i.e. purely cash crops — are produced. This sort of farming does not show any specialization, therefore agricultural production is classified as mixed-type farming.

Since the mountains, which are made up mostly of limestones and dolomites, are highly eroded, the pastures, which are fairly extended, yield but a very poor grass.

The relatively cool and humid climate, however, favours a good fodder produce in the basins and valleys, where cattle-holding prospers. But even

FIG. 11. Land utilization in one of the basins of the Transdanubian Central Mountains (region 3)

the poorly-grassed pastures, which occupy much larger areas here than in the regions discussed above, provide means for sheep-grazing.

On the southward slope of the fault trough running between the Bakony Mts and the Vértes Mts, a rather good wine-district (Mór Wine-District), has been developed. Some fruit-growing also takes place on the slopes. The barren hill-sides could be used for berry growing fairly well (raspberry, black currant, etc.); the produce of the first plantations has been excellent.

As the region possesses little area suitable for agriculture, specialization ought to be developed along the line of cattle-holding.

(4) The *Balaton Region* is a small area and properly comprises the marginal zones of the surrounding landscapes; it has been contracted into one region by the uniform pattern of holiday resorts.

Lake Balaton, the largest fresh-water lake of Hungary (and of Central Europe), lies in a recent fault trough. The lake has a surface area of 600 km^2, its water is shallow: its depths average between 3 and 4 m.

The northern shore of Lake Balaton is bordered by the southern foreland of the Bakony Mts. This bench-land is called Balaton Hill-country. Its eastern part is made up of dolomites, while in the west the basalt sheets are common. The latter zone is covered with loessy soil mingled with pyroclastic materials which is excellent for vine-growing. This region in general, but especially on the leeward, southern slopes of the Bakony Mountains which abound in vineyards and orchards, shows many mediterranean features.

The ridges of the Somogy Hill Country, bearing a thick loess series, run squarely up to the southern shore of the lake. In the western zone, water-logged, boggy areas extend into the wide flats of the ridges. The soils of the valleys and slopes are good chernozems, formed on loesses. On the short slopes there is a tendency to soil erosion. On this southern shore almost all the plant crops indigenous to Hungary can be raised.

The Balaton Region as an agricultural entity has a special character. More than 1 million visitors yearly make an immense market, though for a relatively short period (June-September) and mainly for fruits and vegetables. The agricultural areas along the lake shore have already been turned into summer resort places, but the hinterlands are still agrarian, belonging mainly to the state farms.

The type of production can be classified as a vine- and fruit-growing, especially on the northern shore. The Balaton Hill-country is traditionally a wine-district, the second one in rank and extent in the country, where vine-growing goes back as far as the Roman epoch. The continuous belt of vine plantations stretches along the near-shore slopes. The wines of this region, surpassed in quality only by the famous Tokay wine, are also important from the point of view of exportation. The climate, which is largely affected by Mediterranean influences, favours some special branches of production such as aromatic and volatile oil crops (lavender); almonds have also been developed. A considerable part of the vine area has remained under private management, because it would have been extremely difficult to set up mechanized, commercial vine-plantations on such rough terrain.

The structure of production along the southern shore is hardly able to meet the demands of the holiday resorts. As a matter of fact, the ratio of the

FIG. 12. Vine-lands on the slopes of the Badacsony Mt. (region 4)

FIG. 13. Irrigation of vine-scions (region 4)

area of vegetable growing does not reach the national average, so that a large quantity of vegetables must be transported from other regions. However, with careful planning the natural conditions would permit an adequate supply from the local resources (even with a further increase in tourism), and what is more, sufficient fruit crops could be produced to justify setting up a preserving factory. At present, the ratio of cereals seems to be very high. In spite of the fact that the agricultural population of the poorly industrialized region is relatively high (45%), there is a deficiency of manpower during the peak growing season of vegetables, because the holiday resorts absorb many seasonal workers from the local population. At any rate, the southern shore should also be developed for horticulture; its current production type properly corresponds to mixed farming.

Owing to the vine- and fruit-growing character of the area, stock-farming is naturally less important than it is in the regions discussed hitherto.

(5) The *Mezőföld* is mostly a flat landscape, but its southern part represents a rolling country covered by loesses. Its flatland shows many features similar to those of the Great Plain (some authors consider it as belonging to the latter), from which it is separated by the Danube valley. The Mezőföld is 50 to 60 m higher than the Danube valley. Therefore, its eastern fringes have been dissected by the deep valleys of the streams flowing to the Danube. On the surface of the loess platforms and bound-sands occurring in the region, excellent chernozem soils have been formed, on which most Hungarian crops can be raised very well. The clayey meadow soils on the flood-plain of the Sió—Sárvíz are covered with meadows and pastures. The continental character of the climate is more pronounced here than in the other parts of Transdanubia. So it represents a transition to the Great Plain in this respect, too.

The southern part of the region is a dissected rolling country covered by loesses (a similar landscape borders the southern shore of Lake Balaton). Here the conditions for production are the same as in the flatland, but the amount of erosion is high. The gentle slopes are good for tillage.

The land utilization accords with the flatland character of the region: the arable land is about 80% of the total agricultural area.

The northern part of the region is beginning to be industrialized. Recently in the area surrounding Lake Velence, a district of summer resorts has developed. The southern zone has, in turn, an entirely agrarian character.

The type of production can be classified as mixed-farming. This mixed-farming is, however, the result of factors which differ from those in region 3. In the Mezőföld the system of farming has undergone radical changes since World War II. Up to the war, a great number of latifundia did exist in the region, also individual peasant farms (in the southern zone), owned in part by the German minority, had largely surpassed in size the national average. These big farms specialized in large-scale cultivation of roughages that gave rise to dairy-farming, the products of which were chiefly marketed in Budapest. After the war, the agrarian reform and the expatriation of the German minority adversely affected the specialization of production. Cattle-holding and bread grain production declined materially, while maize-growing, absorbing much labour under the conditions of small-peasant farming, made great strides. The region became the most important maize belt in Hungary (this crop accounts for 1/3 of the arable land in the region). Commercial maize production and pig-breeding are also considerable.

The yield averages are fairly good.

The production type of the region is to be developed along the line of stock-farming. The neglect of cattle-breeding is unreasonable, since the region possesses excellent conditions for lucerne-growing. The proximity of the Capital and of Lake Balaton, as well as the possibilities for irrigation, argue for the development of large-scale vegetable production.

(6) *South-East Transdanubia* is divided, from the point of view of physical geography, into three parts: a flatland, a rolling country and a mountain landscape.

The *flatland* represents the westernmost outshoot of the Great Plain. It is called the Dráva Region. It is a flood-plain covered by alluvial soils, interrupted at intervals by river-bank dunes. Its climate is subject to Mediterranean influences: having a warm summer and precipitation reaching its peak in autumn. The soils commonly require improvement. There are fairly good possibilities for crop-farming.

The *rolling country* bordering the Mecsek Mts is covered by loesses and intensively dissected by minor valleys, ravines, and gullies. In the area there are excellent chernozem soils, so the hill ridges are also cultivated.

The *Mecsek Mountains* emerge, with a scarcely perceivable transition, like a group of isles from the rolling landscape. The southern edge dips abruptly onto the plain which is interrupted farther to the south by the *Villány Mountains*. The southern slopes of the 400 to 600 m high Mecsek Mts and of the 400 m high Villány Mts, being protected from the north winds, have a very advantageous climate for vine- and fruit-growing. The natural vegetation also enjoys potent Mediterranean influences.

A considerable part of the region is unsuitable for agriculture. In Pécs and its surroundings (Komló) an important mining and industrial centre has been developed. The densely populated southern flatland, however, can be defined as a rural area where the ratio of agricultural population exceeds the national average.

It is not easy to determine the production type of the region. Its stock-farming character is unquestionable, but the mountain area is featured by cattle-holding, while the flatland is dominated by pig- and poultry-farming.

As to crop-farming, the large-scale production of coarse grains takes up nearly half of the arable land. At the same time, the crop ratio of bread grains is the lowest here of all the regions.

The yield average can be considered as poor.

A shift in population after World War II caused disruption in the stock-farming of this region, too. The density of cattle is only little higher than the average for the Great Plain. On the other hand, as regards pig-breeding, this is the most important region of Transdanubia.

In the region on the southern slopes of the mountains there are two minor wine-districts that produce very good wines. Fruit-growing is also noteworthy. Since spring usually sets in early, there are wide possibilities for producing primeur vegetables, which are now exploited only in low degree.

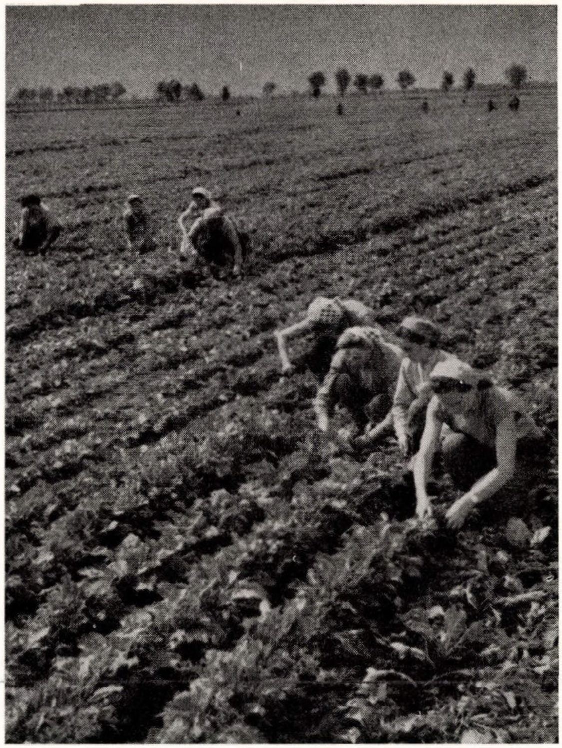


FIG. 14. Sugar-beet field in a co-operative farm in the Danube Valley (region 7)

(7) The *Danube Valley* follows the meridional course of the Danube from Csepel Island down to the Yugoslav border. Its physiography is completed in the south by a fringe of the Vojvodina Loess Ridge extending up from Yugoslavia.

The surface is perfectly flat, being marked only by some isolated ranges of sand dunes. Prior to the middle of the 19th century, i.e. before the regulation of the rivers, the region had been widely covered by flood-plains and marshes. The artificial drainage rendered the land fertile, but gave rise, at the same time, to a process of alkalization. Patches of sziksoils are frequent especially in the eastern marginal area, where they are used for grazing. In general, the soils are fertile chernozems and recent flood-plain loams.

The Bácska Loess Platform is covered by high-quality chernozems. This is one of the most fertile landscapes of Hungary.

The region has a very good climate: its southern part benefits from many sunny hours; the amount of heat in the growing season is high, and the precipitation is more abundant than in the areas of the Great Plain with similar temperature. These factors are favourable for plant cultures requiring much heat and for the production of primeur crops.

The lands are utilized, like in all agrarian regions of Hungary, mainly by crop-farming which occupies more than 3/4 of the area cultivated. On the river terraces of the right bank of the Danube, an extensive viniculture is carried on.

Agriculture is the most important economic activity within the region; its main type of production can be characterized as pig-breeding.

Of the field crops, large-scale maize-growing is predominant ($35^0/_0$ of the total crop area); and it does not reach such a high rate as this in any other region. The growing of maize and its use to fatten pigs is an old tradition here. So the production type of the region is pig-breeding.

Some industrial crops (hemp) and vegetables are also worthy of mention. The production of the red-paprika (in the vicinity of Kalocsa) surpasses the output of the famous Szeged district. Early green peas, as well as the paprika are produced for foreign markets. There are good conditions for farming under irrigation, but because the region is not liable to droughts, little attention has been paid to such facilities.

Cattle-breeding is insignificant. Relatively important is sheep-holding, the intensive forms of which are also known (while in the other parts of the country sheep are raised only for the utilization of the poor pastures).

(8) The agricultural production type of the *Surroundings of Budapest* is unique. It has developed in response to the consumption demands of the Budapest market for fresh produce, and it actually supplies about half or two-thirds of the necessary vegetables and fruits. However, the milk supplied by the region is altogether insignificant, owing to the insufficient land available for fodder production. Most of Budapest's milk supply is transported from places as distant as 150 km on the average.

The region has a complex physiographic pattern, its boundaries are defined mainly by economic factors.

Along the right bank of the Danube there stretches a mountain landscape consisting of the Buda Mts, the Pilis Mts and the volcanic range of Visegrád—Szentendre. The peneplains 400 to 700 m high confine small basins which, because of their position in the rain shadow, are dry and lack appreciable agriculture. The mountains are covered with forests. Agriculture is worth mentioning only on the southern slopes of the Buda Mountains where the highly calcareous rendzina soils have given rise to the development of the richest peach-district in the country.

The left riverine makes a flatland. The Pest Plain south of the capital is a section of the Danube Valley. The south-eastern section belongs to the Sand Ridge of the Danube—Tisza Midregion, a Pleistocene alluvial fan of the Danube. The surface is mostly covered by blown-sands, interrupted by minor depressions with sziksoils. In the northern and eastern borderlands, large patches of loess are encountered, on which fertile, loamy soils have been formed.

The climate of the region is warm and dry with continental influences. Surface water streams occur in the boundary areas only. They (as well as the Danube) supply water for irrigation; recently the groundwaters of the buried alluvial gravels have also been tapped for irrigation by means of tube wells. As this area provides more than half of the production value of Hungarian industry, agriculture is a subsidiary branch. Families are very frequently engaged in two occupations (some members are engaged in industry, others in agriculture). Of course, the labour-absorbing branches of the widespread and varied industry have a stronger appeal, but in the highly profitable agricultural seasons (such as grape harvest time) the part-time farmers are often absent from the factories.

The structure of land utilization hardly differs from the national average, only the proportion of the vine area is high.

The soils of low fertility have very low efficiency in growing the traditional crops of the Great Plain, and the yields fall short of the national average. Yet, grain crops occupy 68% of the crop area (the ratio of bread grains is 26%). Vegetable produce is also very intensive; its growing area is four times the national average. Potato-growing is particularly large in area and volume.

The results of vegetable-growing are quite good, though conditions do not lend themselves to raising primeur products. Recently, hothouse production has grown.

Agriculture is complemented by fruit-growing, which is remunerative especially in peaches.

Since the sandy areas are unfavourable for fodder production, the livestock of the region is markedly poor. The scarcity of cattle is striking. The families with two occupations usually can afford to keep pigs and poultry; at current prices it would be unprofitable to feed cattle on bought fodder.

The region should be further developed along the lines of actual specialization. The agrarian population is not likely to decrease considerable in the near future, because the appeal of the Capital is most potent for the people in under-developed frontier regions. In fact, agriculture which is keyed to provision Budapest can ensure to its producers an income equal to or even higher than the wages of industrial workers.

(9) The *Central Mountains of North Hungary* show many features similar —from the point of view of rural economy—to those of the Transdanubian Central Mountains (region 3). In the mountainous areas the mining and processing industry are more developed than they are in the Transdanubian Central Mountains; and the relief and the widespread forests of the mountains preclude agriculture almost entirely. At the same time, the range of basins along the northern fringes of the mountains and the river valleys make up a major agricultural area, so the agrarian population is proportionally high (31%). The area of these basins is about 180 km long and 20 to 60 km wide, and stretches beyond the frontier into Czechoslovakia. Also these basins used to be covered by forests which have left a slightly leached forest soil behind. The extensive Borsod Basin is connected with the Great Plain by the broad valley of the Sajó River.

The climate, rich in precipitation but rather cool, coupled with soils of low fertility, does not offer favourable conditions for agriculture.

These disadvantageous factors are made still worse by the social conditions. Families of double occupation are nearly as prevalent as in region 8. Although the abundant precipitation promotes the growth of grasses even on poor soils, an adequate cattle-farming could not be developed, for the population mainly works in industry. The agricultural production is of cattle-breeding type.

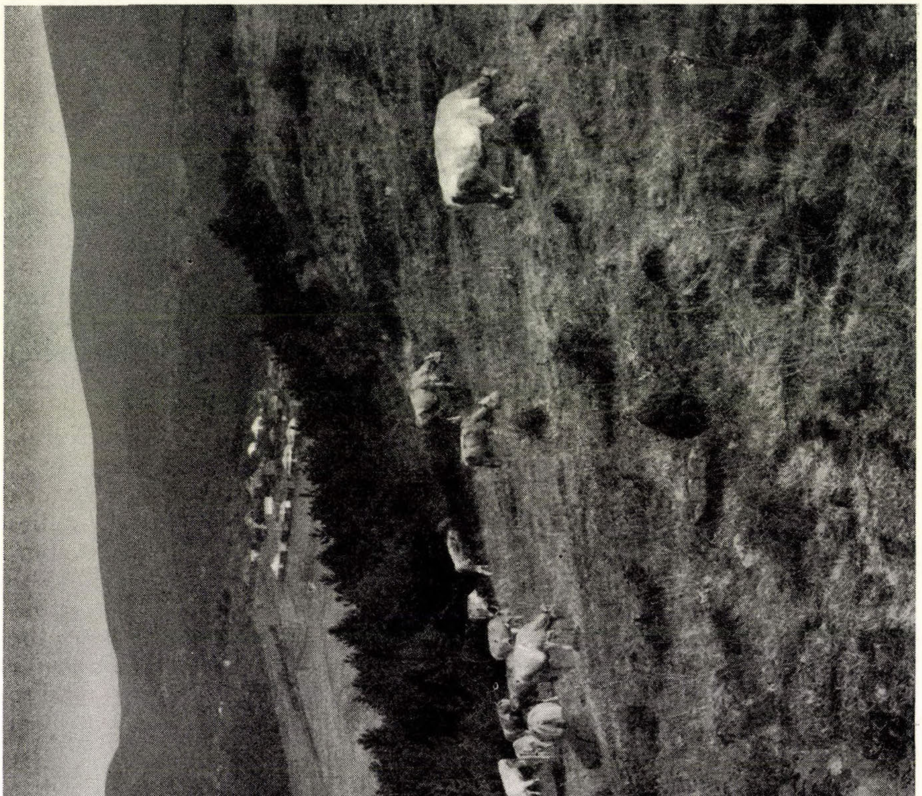


FIG. 15. Hill pasture (region 9)

The proportionate area of pasture land is the highest in the country. Though not bad in quality, pastures can often be utilized for sheep-grazing only, owing to the rough terrain.

Grain crops are disproportionately widespread. Maize is less favoured by the cool climate, but the wheat ratio is almost as high as in the Great Plain and certainly higher than it is on Transdanubian plains. However, the very low yields suggest reduction of cereals raising. The production of potato and roughages is more feasible.

Of the fruit species grown, plum is the commonest; however, it cannot be regarded as a source of income, for there is little demand for plums in Hungary.

The good conditions for fodder production made cattle-breeding important, while the mountain pastures are favourable for sheep-grazing. Cattle-breeding seems to be the most promising for specialization, but it must be thoroughly improved.

(10) The *Foreland of the Central Mountains of North Hungary* represents a transition between the mountain region and the Great Plain. It is characterized by gentle piedmont slopes covered by a continuous range of flat alluvial fans. Its soil, which was initially forest made, now has a chernozem dynamism and is highly fertile. The slopes with southern exposure have a favourable influence on the mesoclimate.

The region includes both plain and mountain landscapes (the Tokaj Mts); this complexity results in mixed farming, but some sectors (mainly the wine-districts) show a distinct specialization (Tokay wine).

The ratio of the rural population is only a little higher than in the Central Mountains of North Hungary, but the per capita crop area is smaller and so the agrarian character is more pronounced.

Large areas are utilized for vine plantations. Of the numerous wine-districts situated on the southern slopes, the wines of Tokaj and Eger have a high reputation all over the world. The total area of meadows and pastures is also large. The arable land is about 2/3 of the agricultural area, its ratio being the smallest of all the regions.

The distribution of the crop area differs hardly at all from the average. None of the crops are outstanding by the national scale.

In stock-farming, the role of cattle is somewhat lesser, while that of pigs is somewhat greater, than in the mountain region.

An intensive specialization cannot be recommended for this zone, precisely because of its transitional character. The vine plantations must be renewed, as the vine-stocks now are too old and deficient and the yields are, for this reason, very low.

(11) The *Tisza Region* is a most characteristic landscape of the Great Plain, showing all the features which are often ascribed to the whole of Hungarian agriculture by foreign geographers.

The Tisza Region is a large level plain on which the biggest prominences are only a few meters high. The region having an apparently uniform topography, is composed of several minor landscape subdivisions. In the south-west, a loess platform covered by excellent chernozem soils extends along the middle course of the Tisza. This is the driest part of Hungary, where the annual precipitation is 450 to 500 mm. North-east of this loess platform is

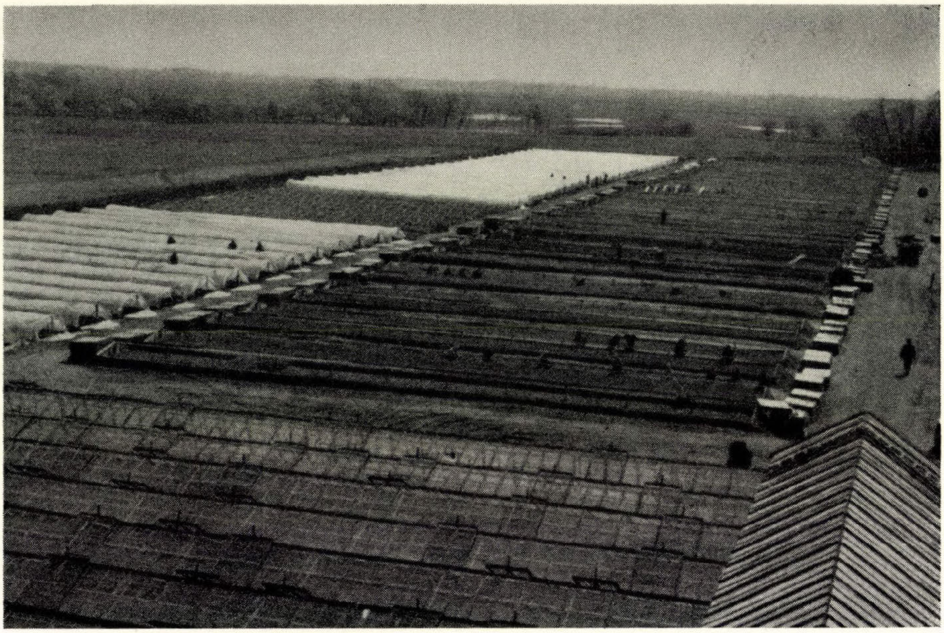


FIG. 16. A prospect of modern lowland agriculture: primeur vegetables in a co-operative farm in the Tisza Valley (region 11)

situated the low-seated grassy plain (puszta) of the *Hortobágy*. Since the Great Plain waters and the Tisza were regulated (about 100 years ago), the originally humid grasslands have turned into intensively alkalizing, dry pastures of low quality. Though the soil-melioration and irrigation undertaken after World War II have greatly altered the landscape, it did not stop being an area of extensive stock-farming. In the infertile depressions covered by sziksoils, many fishponds have been established. Finally, the eastern part of the region is a higher-seated loess platform covered by chernozem soils. It is separated from the Hortobágy by a navigable canal built for irrigation 10 years ago (the Eastern Main Canal).

The region has a warm, dry climate; the distribution of precipitation is extremely variable. This is the area most frequented by drought. The precipitation increases to the east of the region.

The surface water streams are few but relatively large, so they can be used for irrigation.

The Tisza Region is one of the least industrialized areas of Hungary. Its production type may be characterized by pig-breeding.

Where the soil conditions are suitable, crop-farming is carried on. The largest irrigated area of Hungary lies here: it is used mainly for growing rice and other field crops.

Cereals occupy 2/3 of the arable land, which proportion is higher than the national average. This is the most important wheat-producing area of the

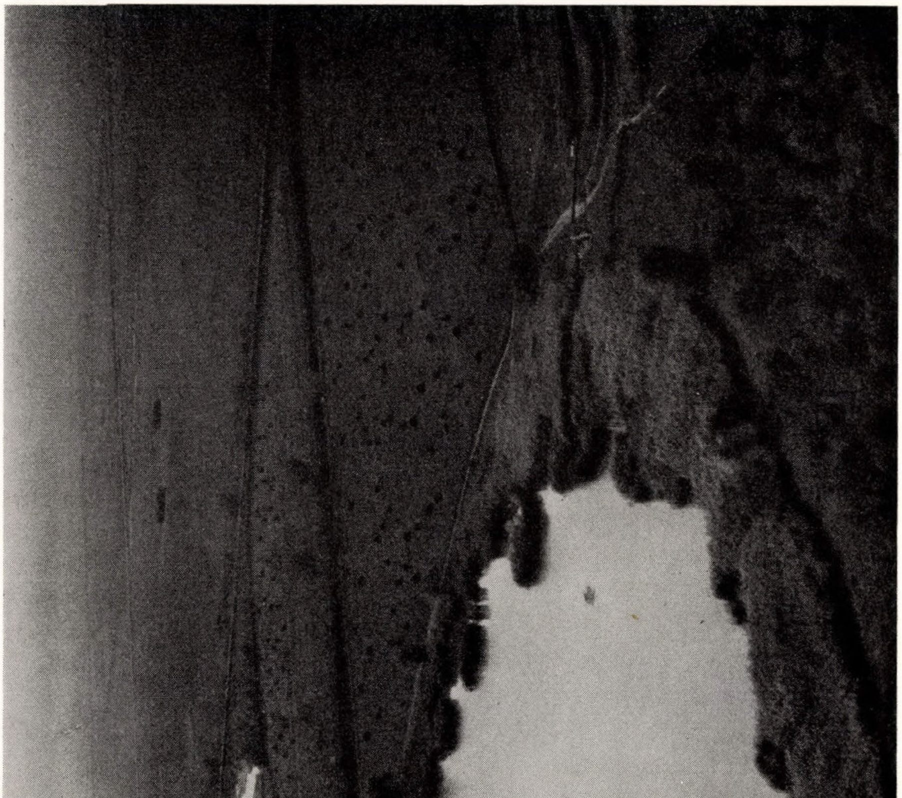


FIG. 17. Landscape in the Tisza Valley (region 11)

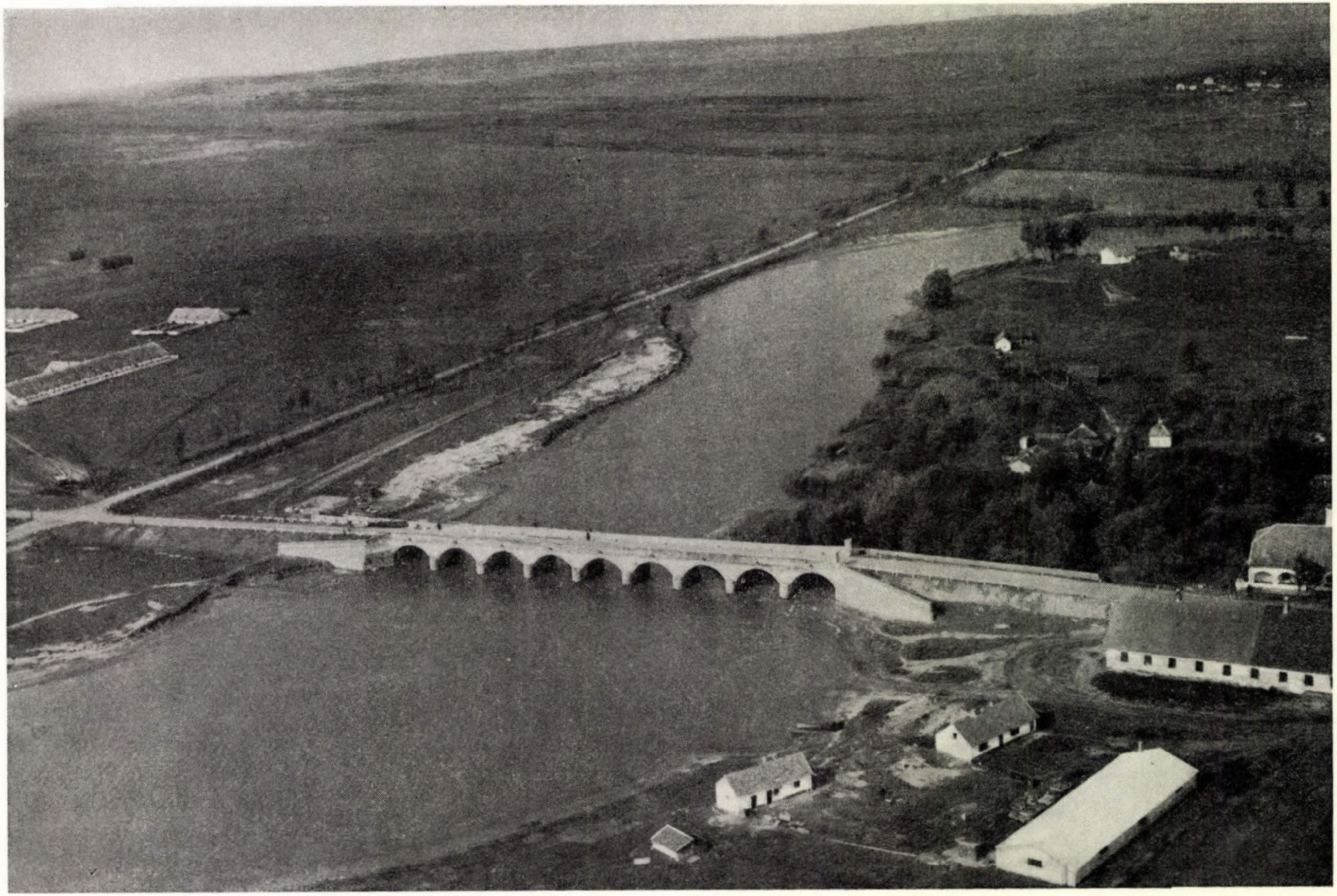


FIG. 18. River Hortobágy and the "Magyar puszta" (region 11)

country. The production of industrial crops (sugar-beet and sunflower) is also worthy of mention.

The yields may be regarded as medium. The effects of drought are counterbalanced by the high fertility of the chernozems.

In stock-farming, pigs and sheep are predominant. The density of sheep here is the highest in Hungary, sheep-farming being the only way to utilize the irreclaimable alkaline grasslands, which are regrettably widespread in this region.

Owing to a rapid development in farming under irrigation, the region is facing a great change. A large district of vegetable-culture under irrigation can be established here; plans for a preserving factory also have been designed. As the conditions for a more intensive fodder production by means of irrigation are being developed, cattle-breeding may overcome its subordinate role.

(12) The *Danube—Tisza Midregion* is understood in this paper as covering roughly the Sand Ridge mentioned already in connection with Region 8. The surface is made up of blown-sands which are frequently interrupted by alkalized depressions. Minor spots of sands are moving even today, but most of them have been bound by vegetation. The dune ranges of blown-sands have a topsoil of a very poor nutritive power, and their water regime is inadequate. Plenty of sunny hours make the climate dry. The region has the worst possible physical conditions for field crops. The possibilities of horticulture are better.

The Sand Ridge is bordered in the east by the Tisza Valley, from which it is separated by a distinct edge. The alluvial flood-plains are covered mostly by meadows and pastures. The Tisza Valley is the lowest part of the Great Plain, i.e. it represents the base level of erosion.

Many successful attempts have been made in the past to bind the blown-sands, which of course are unsuitable for agriculture in a loose state, by means of afforestation or vine and fruit-tree plantation. So horticulture is a very old tradition in this region. Accordingly, the density of the agrarian population is high.

Land utilization here is marked by Hungary's largest wine-producing area; it supplies about half the total wine output of the country. This area was of special importance at the end of the 19th century, when phylloxerae decimated the vine plantations in the mountains, while the vines grown on sandy soils proved to be immune. The wines of this region are not equal in quality to those of the mountainous wine-districts with centuries-old traditions; they are raised for domestic mass consumption. The flat surface permits large-scale mechanization, so the aged plantations can be successively replaced by new ones. Dessert grapes have fairly good conditions. The irrigation of vines by tube wells has been started quite recently.

The meadows and pastures have a rather considerable expansion. The meadows lie in the alkalized despressions, where spring thaw-waters are apt to accumulate and stagnate, thus compensating for the deficiency of rainfall. By the end of the summer these meadows turn from bad to worse, and in general they can be used for grazing only. The pastures are situated on the poorest sandy soils and have a very low yield.

FIG. 19. Irrigated rice-fields (region 11)

FIG. 20. Horse-pasturing in the Hortobágy (region 11)

The conditions for crop-farming are rather bad; on the dry sandy soils the yields are low. Rye is sown in 1/5 of the crop area (mostly for self-sufficiency) and harvests are extremely poor. Of the coarse grains, maize is the most tolerant of the poor soil conditions, therefore it is raised throughout the area, though with similarly inadequate results. Cereals occupy more than 3/4 of the total crop area; this is the highest ratio in the country.

Of the vegetables, tomato and paprika are worthy of mention.

Roughages are produced to an extremely low extent. The peasants in this region are not familiar with the kinds of fodder crops which are tolerant of sandy soils; such crops are encountered only in some state farms. Their ratio ought to be increased by all means, at the expense of the area devoted to cereals.

An upswing of the economy in this region may be expected, above all from vine- and fruit-growing, which determine the type of production. While the new vine plantations, set mainly to refresh the aged vineyards, do not substantially enlarge the total area, the pace at which new orchards are brought to life can be called rapid.

Of all the regions of Hungary, the Danube—Tisza Midregion possesses the greatest number of fruit-trees. The ratio of the commercial orchards is low, the majority of the trees have been planted in vineyards. The new plantations can no longer maintain this double farming. Apricot, peach and morello cherry are the fruit species of the greatest importance, apricot in the surroundings of Kecskemét, the other ones around Szeged. Early ripening brings them to market as primeurs, while the long sunny period is favourable for their quality.

It follows from the composition of the field crops that stock-farming plays a subordinate role. The needs of horticulture for organic fertilizers are covered partly by leaf-mould, partly by farmyard manure supplied from Transdanubia. The number of horses is considerable, which is due to the needs of the scattered farmstead-type settlement.

(13) The surface of the *Nyírség* resembles in many respects the Sand Ridge of the Danube—Tisza Midregion. It is also an alluvial fan accumulated by the Tisza and its tributaries. It is almost entirely covered by blown-sand sheets, only between the meridional dune ranges there are drainless depressions, small bogs and ponds. For all these similarities, the Nyírség has sands with a higher humus content, more fertile soils and more even and abundant precipitation. The sands are leached here, while in region 12 they are calcareous.

The eastern zone of the region, i.e. the Szatmár-Bereg Plain, represents a recent subsidence which had been covered by swamps till the end of the last century. The boggy, meadow-clayey soils can be tilled only with difficulty, though they are rich in nutrients.

The Nyírség is the least industrialized area of the country (as shown also by great migration losses). Still the ratio and density of the agrarian population are high. Attempts have been made to provide employment for excess manpower by means of intensive crop-farming.

As regards land utilization, the ratio of arable land is huge (85%), all other branches of production being insignificant.

FIG. 21. Farmsteads in the Great Plain (region 11)

Of the production branches, potato-growing answers the criteria of a production type. In addition, the region is an important growing area of some more highly precious crops.

The crop ratio of the cereals is the lowest in the country here, but that of the potato, covering 15% of the arable land, determines the production type of the region. Hungary is provisioned with cooking potatoes almost entirely from here. A small quantity of the same crop is used for foraging. Some industrial plants, especially sunflower and tobacco, are also grown successfully. Lack of a local market for the moment keeps the production of vegetables on a medium-scale, but great improvement is likely to take place as soon as the planned preserving factories are built.

The growing of winter apples is highly developed in the Nyírség. The ratio of commercial apple orchards is high as the greatest ammount of this fruit is being produced on modern plantations, the number of which is steadily increasing. Winter apple is one of the most important items of Hungary's agricultural balance, and an increasing export, especially to the northern members of the CMEA, is to be expected.

Since fodder production has a medium spread with fairly good yields, stock-farming is much more developed here than it is in the Sand Area of the Danube—Tisza Midregion. As regards cattle-breeding, the Nyírség is the third (quantitatively) among the regions of Hungary, but this is partly explained by the fact that cows are utilized also as draught animals. The pig stock is also high.

FIG. 22. Cattle-grazing on the pastures along the Tisza (region 13)

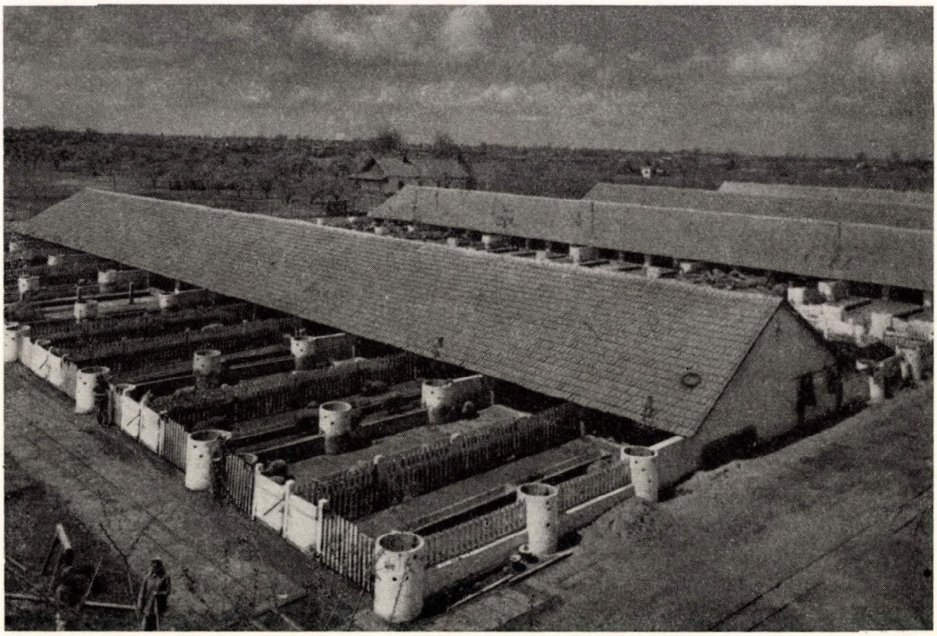


FIG. 23. Piggery in the South-East Great Plain (region 14)

The agriculture of the Nyírség is coming up in the lists of intensive farming without any striking inequalities. The productivity (production value per labourer) of the best orchards is not inferior to that of industry; so the economy of the region may be developed even at a relatively slower pace of industrialization.

(14) *The South-East Part of the Great Plain* is bordered by the rivers Körös, Maros and Tisza and is a level plain. Its substrate is made up of the alluvial fan of the Maros, which is overlain almost everywhere by loesses. The latter have given rise to the formation of excellent chernozems, the most fertile soils of Hungary. In the lower-seated areas the subsoil is alkalized. The valley of the rivers Körös is covered with alluvial clays.

This is the warmest region of the country; the precipitation is more abundant than in the Tisza Region. The excellent soils fairly compensate the droughts, and the yields are good.

The region is predominantly agrarian, though industry has made some progress since World War II. Prior to the war, the ratio of landless peasants was the highest here.

The main production belongs to the pig- and poultry-breeding type.

Land utilization consists in cropland-farming; further, we may mention the pastures chiefly situated on the sziksoils along the banks of the Körös. The chernozem soils in the central parts are almost exclusively utilized as arable lands, their ratio being higher than 90%.

Of the field crops, maize, wheat and sugar-beet are outstanding. All three crops are raised under favourable conditions, with good results. Rice is successfully grown on the clay soils of the Körös Valley. The specialization of some specimen crops has been started in several minor districts. Some stenothermic crops (broomcorn, ricinus, arachis) are raised only here in all Hungary. The production of onions is also well known: nearly half of the national production of onions is produced by 3 or 4 localities along the Maros.

Vegetable-culture under irrigation has been traditional along the Körös. The preserving factory at Békéscsaba, which is already in the stage of completion, will stimulate larger-scale production.

For the agricultural area, the pig and poultry stocks are markedly the greatest in the country here. It is this region that supplies the largest quantities of pork and slaughtered poultry both for the industrial districts and for export.

It appears that the structure of production need not be materially changed in the future.

Bibliography

Asztalos, I. (1962) Magyarország baromfitenyésztésének gazdasági földrajzi vizsgálata (Economic geographical study of poultry-farming in Hungary), *FÉ*, vol. XI, 109—31

Asztalos, I., Sárfalvi, B. (1960) A Duna—Tisza köze mezőgazdasági földrajza (Agrogeography of the Danube—Tisza Midregion), Akadémiai Kiadó, Budapest, 394

Bernát, T. (1959) Búzatermesztésünk néhány gazdasági földrajzi problémája (Some economic geographical problems of wheat-growing in Hungary), *FK*, vol. LXXXIII, 131—50

Bernát, T. (1960) Rozstermelésünk néhány gazdasági földrajzi vonatkozása (Some economic geographical problems of rye-growing in Hungary), *FK*, vol. LXXXIV, 125—39

Bernát, T., Enyedi, Gy. (1961) A magyar mezőgazdaság termelési körzetei (Production regions of agriculture in Hungary), Mezőgazd. Kiadó, Budapest, 166

Bora, Gy. (1956) A rizstermelés Magyarországon (Rice production in Hungary), *FK*, vol. LXXX, 275—7

Cravero, R. (1957) A magyar baromfitenyésztés gazdaságföldrajzi képe 1954-ben (Economic geographical pattern of poultry-farming in Hungary, 1954), *FÉ*, vol. VI, 199—220

Elek, L. (1956) Gyümölcstermelő tájak és tájoptimumok kutatása (Research of fruit-producing landscapes and landscape optima), *FÉ*, vol. V, 324—40

Erdei, F., Csete, L., Márton, J. (1959) A termelési körzetek és a specializáció a mezőgazdaságban (Production regions and specialization in agriculture), Közgazd. és Jogi Kiadó, Budapest

Enyedi, Gy. (1957a) A kukorica Magyarországon (The maize in Hungary), *FK*, vol. LXXXI, 17—32

Enyedi, Gy. (1957b) A mezőgazdasági körzetek kutatásának új módszeréről (A new method of investigation of the agricultural regions), *AtEÉK*, Budapest

Enyedi, Gy. (1958) Cukorrépatermesztésünk agrárföldrajzi vázlata (Agrogeographical pattern of sugar-beet production in Hungary), *FK*, vol. LXXXII, 131—60

Enyedi, Gy. (1959) Lucernatermesztésünk agrárföldrajzi vizsgálata (Agrogeographical study of lucerne-growing in Hungary), *FK*, vol. LXXXIII, 265—81

Enyedi, Gy. (1960a) La cartographie de l'utilisation du sol de la Hongrie. *Études sur les sciences géographiques hongroises*, Akadémiai Kiadó, Budapest, 65—71

Enyedi, Gy. (1960b) A területhasznosítási (land use) térképezés (Land use mapping), *AtEÉK*, Budapest

Enyedi, Gy. (1961) Földrajzi munkamegosztás és termelési körzetek a mezőgazdaságban (Geographical division of labour and production regions in agriculture), *FÉ*, vol. X, 153—72

Enyedi, Gy., G. Szabó, M. (1955) A Délkelet Alföld mezőgazdasági földrajzának alapvonásai (Basic features of the agrogeography of the South-eastern Great Plain), *FÉ*, vol. IV, 445—64

Gyenes, L. (1960) A komplex termőtájkutató munkák helye, szerepe és jelentősége a földrajztudományokban (The location, role and significance of the complex investigations into agricultural regions in the geographical sciences), *FÉ*, vol. IX, 423—38

Papp, A. (1961) A püspökladányi járás mezőgazdasági földrajza (Agrogeography of the Püspökladány district), *FÉ*, vol. X

Pénzes, I. (1957) Adatok a szegedi fűszerpaprika talajföldrajzához (Contributions to the soil geography of the Szeged red paprika), *FÉ*, vol. VI, 57—77

Wallner, E. (1958) A paksi járás mezőgazdasági földrajzának alapvonásai (Basic features of the agrogeography of the Paks district), *FÉ*, vol. VII, 53—95

Zombai, P. (1954) A talajviszonyok szerepe a Mezőföld mezőgazdaságában (The function of the soil conditions in the agriculture of the Mezőföld), *FÉ*, vol. III, 455—480

CORRELATIONS BETWEEN FODDER PRODUCTION AND STOCK-FARMING IN HUNGARY

by ISTVÁN ASZTALOS

Stock-farming is apparently controlled by the production of fodder, the quality, quantity and structure of which determine the character of livestock breeding. At the same time the volume of the fodder basis is determined by the domestic and export needs for animals and animal products. In Hungary the correspondence between needs and supply is not balanced at present, as the latter cannot afford a considerable increase in the per capita ratio; what is more, production of animal stock sometimes falls behind the current requirements.

Consequently, the key issue of stock-farming is to increase the fodder basis by intensifying the production of such crops as can be best raised under the given physical conditions. Since it is impossible to expand the growing areas, we have to pay more attention to the physical conditions, especially the climatic conditions which are sometimes more determinative than the very properties of the soils.

Of the climatic elements, precipitation is most important in Hungary. The average as observed for many years may be considered as satisfactory. It varies from 500 to 850 mm, and the rainfall of the growing season (April-September) also reaches 300 to 500 mm; however distribution is uneven. In Transdanubia and in the region of the Central Mountains of North Hungary, the annual amount of precipitations is mostly 600 to 800 mm, while at many places in the Great Plain it does not reach 500 mm. In the Great Plain, moreover, dry summers and droughts often have a very bad effect on the sziksoil and sand areas with poor water economy.

Factors responsible for the unsatisfactory fodder production and animal husbandry, in spite of considerable progress made in the last ten years, are the extremes of climate, high temperature, the unsteady and unequal areal distribution of precipitations, the scarcity of nutrients in most Hungarian soils, deficiency of organic matter and bad water economy, coupled with the agrotechnical processes which are not yet everywhere up to date.

Fodder production and the development of stock-farming

Fodder produced on arable land forms the main source of supply for fodder. The yield of meadows and pastures is also considerable, and we cannot disregard the by-products and wastes of field crops (fodder straw, maize stalk, waste slices of sugar-beet, oilcake, bran, wastes of vegetables, etc.).

During the last 6 decades the structure of the fodder-growing area has changed. Animal breeding has grown parallel to the increase of fodder production on arable land, but the ratio of the fodder-growing area to total agricultural area (arable land, meadow, pasture, garden, vineyard) had shown hardly any change till the end of the fifties. In 1895 it was 54%, while between 1935 and 1956 it stagnated at about 56%. However, 1960 shows a powerful development, reflected by a fodder area of 62% of the total agricultural area.

TABLE I

Changes in the composition of the fodder-growing area

	1895		1935		1949		1956		1960	
	cad. yoke	%	cad. yoke	%	cad. yoke	%	cad. yoke	%	cad. yoke	%
Arable land used for fodder production ..	3441	49	4561	62	4531	63	4530	64	5264	68
Meadow-pasture	3593	51	2857	38	2642	37	2520	36	2499	32
Total fodder-growing area	7034	100	7418	100	7173	100	7050	100	7763	100

It is characteristic of the expansion of cropland fodder production that in 1895 the ratio of the natural fodder-producing area (meadow-pasture) to the arable land used for fodder production was 51—49%, while in 1960 the meadows and pastures (32%) were largely overshadowed by the arable land used for fodder production (68%). The changes in the composition of the fodder-growing area took place chiefly before 1935. Since then the natural fodder-growing area has decreased very little (Table I).

In the last 25 years, fodder production kept pace with the development of stock-farming, disregarding slight periodical disturbances. In the same period the specific composition of the livestock has changed considerably (Table II).

TABLE II

Changes in the livestock

	In thousands			%		
	1935	1951—60	1960	1935	1951—60	1960
Cattle	1918	2054	1971	100	107	103
Pigs	4674	5229	5356	100	112	115
Horses	886	699	628	100	79	71
Sheep	1460	1838	2381	100	126	163
Total livestock in animal units	2880	2933	2858	100	102	99

Sheep-breeding developed intensively; pig-breeding showed a fair advance, and the cattle stock has also increased. At the same time, horse-holding declined at a quick pace, owing to the mechanization of agriculture and to the decreasing needs for animal traction power. This has improved the fodder basis of the livestock.

The fodder supply of stock-farming did not make much progress during the last quarter of a century: the total amount of the livestock has remained essentially unchanged since the thirties, while the size of the main fodder-producing area has increased only by 3.7%. Nevertheless, the changes in the structure of fodder production, and particularly the total nutrients produced, indicate some development (Table III).

TABLE III

Percentages of the fodder production related to the average for the years 1931—40 (= 100%)

Crop	Crop area		Yield in starch units	
	1951—60	1960	1951—60	1960
1. Grain crops				
Maize	107	120	125	160
Barley	99	109	120	157
Oats	61	61	66	71
Total	99	110	120	153
2 Rough and soft fodder crops				
Lucerne	120	142	113	103
Red clover	107	143	122	127
Sainfoin	41	33	38	21
Mixture of oats and vetches	59	39	73	44
Green maize and silo maize	122	281	105	228
Other roughages	205	189	204	189
Mangel	63	36	79	47
Total	107	120	108	127
Total (1 + 2)	101	113	116	145
3. Meadows, pasture				
Meadow	78	78	84	69
Pasture	97	96	92	98
Total	88	88	87	79
Total (2 + 3)	95	99	100	108
Total (1 + 2 + 3)	96	104	111	134

While the natural fodder-growing area has decreased, the fodder production on cropland has considerably increased, especially at the end of the fifties. Particularly welcome is the expansion of the roughages, especially that of the leguminous crops. In 1960, the area of the roughages and soft fodder crops exceeded by 20% that of the thirties, and the area of the legumes increased by 32%. The growth of lucerne and red clover is very important for the protein supply of the livestock. The introduction of silage heightened the supply of the green and silo maize and cut down the labour-absorbing mangel which hitherto had been cultivated as the main winter soft fodder. The increase of the other roughage areas shows the effort made in various regions to meet the needs as fully as possible, by producing such crops as are best raised under the prevailing physical conditions.

However, in spite of the decline of horse-breeding, the cattle stock has not increased materially. This is due to the still existing shortage of fodder.

In fact, the growing area of roughages has not increased; even in 1960 it was smaller by about 1.2% than in the thirties, for the losses in the natural fodder-growing area could not be fully compensated for by the increase in cropland roughage production. The area thus reduced can furnish a greater nutritive value, but production could be raised by 8% only even as late as 1960. Accordingly, the development has been rather slow.

More favourable changes have taken place in the production of grain fodders. By 1960, the growing area had increased by more than 10% as compared with 25 years earlier. The area of maize and barley went on increasing, while that of oats was restricted. The livestock is better provisioned with grain fodder than one might conclude from the size of their area, since the production has greatly increased. The average starch yield of coarse grains in the thirties was exceeded by about 20% in the fifties and in 1960 by more than 53%. These changes in the structure of fodder production are also reflected by the composition of the livestock, as pig-breeding is becoming more and more important, and its development is much more intensive than that of cattle.

So fodder production has become more efficient after all. By 1960, the main fodder area, only a little larger than in the thirties, had yielded starch produce 34% higher than the average for the thirties. The increase is due to a more intensive utilization of the arable land for coarse grains production.

The growth and decline of the various fodder crops produced show conspicuous differences from region to region, so the development has not taken place according to a uniform pattern throughout the country. The structure of production has been considerably altered in some regions. The main fodder-growing area has not been materially changed, but the spread of the individual fodder crops has undergone a substantial modification, as seen in Table IV.

The production of fodder crops is characterized by a lesser increase in the traditional areas than in those regions where it has not been so widespread. This is most conspicuous in the case of maize and the leguminous fodder crops.

Maize, traditional in the Great Plain, has gradually shifted towards Transdanubia and North Hungary. During a quarter of a century the acreage of maize has increased by about 28% in Transdanubia, by more than 55% in North Hungary, and only by 11% in the Great Plain, where maize production has lost much of its importance. In the thirties it occupied about 59% of the total crop area; this was reduced to 55% by 1960, while its percentage came up to 35% in Transdanubia and to 10% in North Hungary. The increase of barley was higher in the Great Plain, owing partly to lesser labour requirements and partly to the spread of pigs of the bacon-lard type which utilize the highly albuminous barley very well. The production of oats decreased because of the decline of horse-holding in all three parts of the country, most conspicuously in Transdanubia, which used to be its main growing area.

A balancing tendency is also observed in the production of roughages, above all, in that of legumes. In the Great Plain where the production of roughages used to be underdeveloped, the leguminous crops have increased

TABLE IV

Percentages of the acreage of fodder crops related to 1931—40 (= 100%)

Fodder crops	Transdanubia		Great Plain		North Hungary	
	1951—60	1960	1951—60	1960	1951—60	1960
(1) Coarse grains						
Maize	111	128	101	111	129	155
Barley	101	107	95	113	102	108
Oats	58	56	67	69	61	62
Total	99	110	97	108	108	123
(2) Legume roughages						
Lucerne	113	133	129	156	105	112
Red clover	83	111	149	217	144	174
Sainfoin	47	32	38	33	39	34
Total	89	109	128	160	120	137
(3) Other roughages and soft fodder crops	107	115	106	110	102	104
Total (2 + 3)	99	112	115	130	112	121
Total (1 + 2 + 3)	99	110	102	113	110	122
(4) Meadow, pasture						
Meadow	87	87	66	65	84	83
Pasture	89	89	99	99	100	100
Total	88	88	88	88	95	94
Total (2 + 3 + 4)	92	97	96	100	99	102
Total (1 + 2 + 3 + 4)	95	102	97	104	103	109

at a very quick pace. In 25 years their area increased by 60%; while in Transdanubia it was short of 9%. The Great Plain was always regarded the most important area for growing lucerne; recently its production has become even more voluminous: 56% against 51% in the thirties. Red clover used to be most common in Transdanubia; in 1931—40 more than 60% of the total red clover area was situated there, but this ratio fell to near 48% by 1960. This is not due to decrease of the acreage, rather it can be explained by uneven development: in Transdanubia the growing area increased during 25 years as little as 11%, in the Great Plain it more than doubled (217%), and in North Hungary it became larger by more than half (174%). In Transdanubia the slower development of legumes is somewhat balanced by the growth of annual roughages that have had quicker expansion than the average for the country.

The fodder production on arable land shows an over-all upswing. In North Hungary the crop area increased above 22%. This has involved, however, a partial elimination of the natural fodder area, i.e. of meadows and pastures. So the primary fodder-growing area (arable lands and pastures, meadows primarily used for fodder growing) changed hardly any during 25 years. But the fodder output has increased, for the natural areas (meadows and pastures)—with few exceptions—yield at a much lower rate than do the arable fodder lands. However, this increase is far from being sufficient, for the greatest shortage has been felt precisely in roughages, the growing area of which, in 1960, — apart from North Hungary — did not reach the rate of expansion of the thirties.

The modification of the fodder-growing area and the shifts in its geographical distribution were followed by changes in the structure of stock-farming, the areal distribution of which has also changed (Table V).

TABLE V

Livestock in 1960 in per cent related to 1935

Animal	Transdanubia	Great Plain	North Hungary	All of Hungary
Cattle	91	119	113	103
Pig	98	144	115	115
Horse	69	78	70	71
Sheep	138	203	120	163

In Transdanubia, animal husbandry has not increased numerically. This is largely due to the slow development of fodder production. The exception is in sheep-farming, the extensive form of which is less dependent on the fodder basis. The general decline of horse-holding is most marked in Transdanubia. So a great deal of roughage is left for cattle-breeding, though the slight increase of roughages can improve the foraging only, and does not provide for an increase in the livestock. Traditional cattle-breeding in Transdanubia has never had a secure fodder basis, this is the reason why the livestock has decreased recently. Pig-breeding has not declined materially; in 1960 it fell only 2% short of 1935.

In contrast, the Great Plain and North Hungary are characterized by an over-all upswing of stock-farming, the basis of which is provided by the sudden increase of fodder production, particularly by the spread of legumes. The development has been centred on the Great Plain. The sheep stock doubled, the stock of pigs increased by nearly 50% (the leading role of the traditional area was confirmed), and the cattle stock also exceeded the average by an increase of nearly 20%. In North Hungary the extent of stock-farming was fairly modest, though by no means insignificant. The large-scale upswing of stock-farming in the Great Plain is due to a wise economic policy resulting, here too, in modern, intensive agricultural production, the level of which has become nearly as high as in Transdanubia.

Regional differences in the development of stock-farming have given rise to considerable shifts in the areal distribution of the livestock (Table VI).

The production of roughage shifting towards the Great Plain was linked up with a developing cattle-husbandry. In 1935 the Great Plain accounted for hardly more than 36% of Hungary's cattle stock, while in 1960 its ratio was nearly 42%. This is almost as high as the percentage of Transdanubia, which in 1935 was by about 14% higher than the figure for the Great Plain. Accordingly, the leading role tends to shift from Transdanubia to the Great Plain. Not only cattle but also other animal species (pig, sheep, horse) are getting more and more concentrated on the Great Plain. During 25 years,

TABLE VI

Areal distribution of the livestock per cent

Animal species	Transdanubia		Great Plain		North Hungary		All of Hungary	
	1935	1960	1935	1960	1935	1960	1935	1960
Cattle	50	44	37	42	13	14	100	100
Pig	43	35	47	56	10	9	100	100
Horse	36	34	52	54	12	12	100	100
Sheep	36	30	45	56	19	14	100	100

the Great Plain ratio of pig and sheep stock increased by about 9 to $11^0/_0$, while that of Transdanubia decreased by 6 to $8^0/_0$. The shift took place mostly between the Great Plain and Transdanubia (the function of North Hungary in animal husbandry has hardly changed). Sheep-breeding, however, did not keep pace with the general development of the Great Plain; there the role of sheep-farming has declined, in spite of a relative increase of livestock.

Although, in general, fodder production has developed somewhat more rapidly than the livestock, the problem of fodder basis cannot be considered as settled. In some parts of the country there is a considerable difference between the proportion of the fodder-growing area and that of the livestock. Animal density as related to the fodder-growing area seems to be high in many regions. The density of animal groups per 100 cadastral yokes of main fodder-growing areas is most striking in West and South Transdanubia, North-East Hungary and the South-East Great Plain (Fig. 1).

Cattle- and pig-breeding show a conspicuous geographical differentiation. In North Transdanubia and North-East Hungary, where the production of roughages is most widespread, a high cattle density is to be seen; while the maize-growing areas in the Great Plain and on the riverine of the Danube show an outstanding pig density. Cattle- and pig-farming are closely linked with each other in the north-eastern Great Plain where both animal species have a very high density in relation to the fodder-growing area. This high density is supported by the potato produce which is also largely utilized for feeding animals.

The structure of fodder production and its areal distribution

The fodder produced on arable land plays the most important role in the South-East Great Plain and in the south-west corner of the Danube—Tisza Midregion. In these areas the arable land's share of the main fodder-growing area is $85^0/_0$ or even more. It accounts for more than $70^0/_0$ of the total fodder area in North and South Transdanubia, in a part of the Central Tisza Region and in the northern part of the Danube—Tisza Midregion (Fig. 2).

In other regions the natural fodder-growing areas have become more important. Meadows and pastures make up about 30 to $50^0/_0$ of total fodder-growing area in the south-western and central parts of Transdanubia, in North Hungary and in the central part of the Trans-Tisza Region (Fig. 3). As regards the ratio of meadows to pastures, very great differences are found from region to region. In South-West Transdanubia meadows, while in the Great Plain and in North Hungary pastures predominate. Grassland-farming is most developed in South-West Transdanubia. Its importance is best evidenced by the yield of the grass-lands which is almost as high as that of the roughages grown on arable land. Grasslands in the mentioned regions account for more than a quarter of the main fodder-growing area. The percentage of the mead-

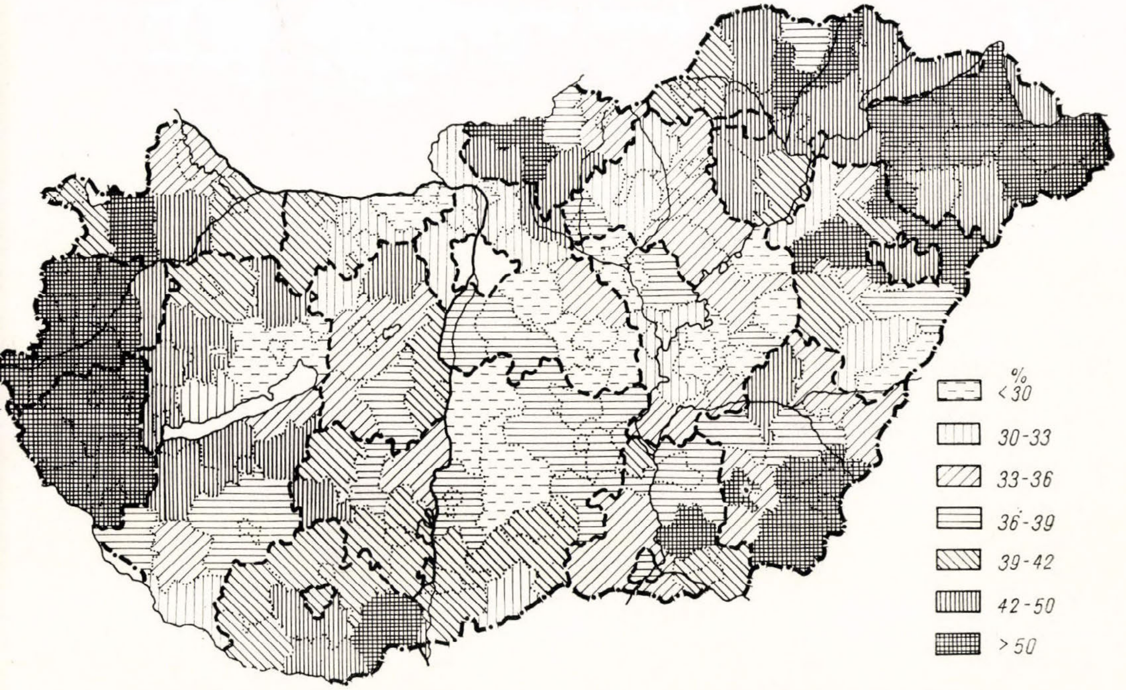


FIG. 1. Density of animal units per 100 cadastral yoke of primary fodder-growing area. 1960

ows varies between 15 and 25% in some parts of the Central Mountains of North Hungary and of the Danube—Tisza Midregion, too, but their area is less than that of the pastures. The latter, situated mostly in the Great Plain, on sziksoils and sands, represent a considerable percentage (about 20% to 40%) of the fodder-producing area. They cannot provide a considerable fodder basis, as they are of a poor quality, and their nutritive value is hardly adequate, particularly in times of drought. Nevertheless, the value and provisioning power of pastures is being increased materially by irrigation.

By now more than half of the arable area is being utilized for fodder production. The predominance of fodder crops raised on arable land is characteristic, above all, of East Transdanubia and partly of the South-East Great Plain (Fig. 4).

Among the fodders raised on arable land, the grain fodders have the leading role. They exceed roughages as to size of area, volume of fodder harvested, as well as starch yield. Coarse grains take up 67.4% of the arable fodder area, as against the 32.6% of roughages. The outstanding role of coarse grains is also reflected by the fact that they account for 46% of the total main fodder-growing area. Of the coarse grains, maize is most important. Its crop area represents nearly one third (31.4%) of the main fodder-growing area.

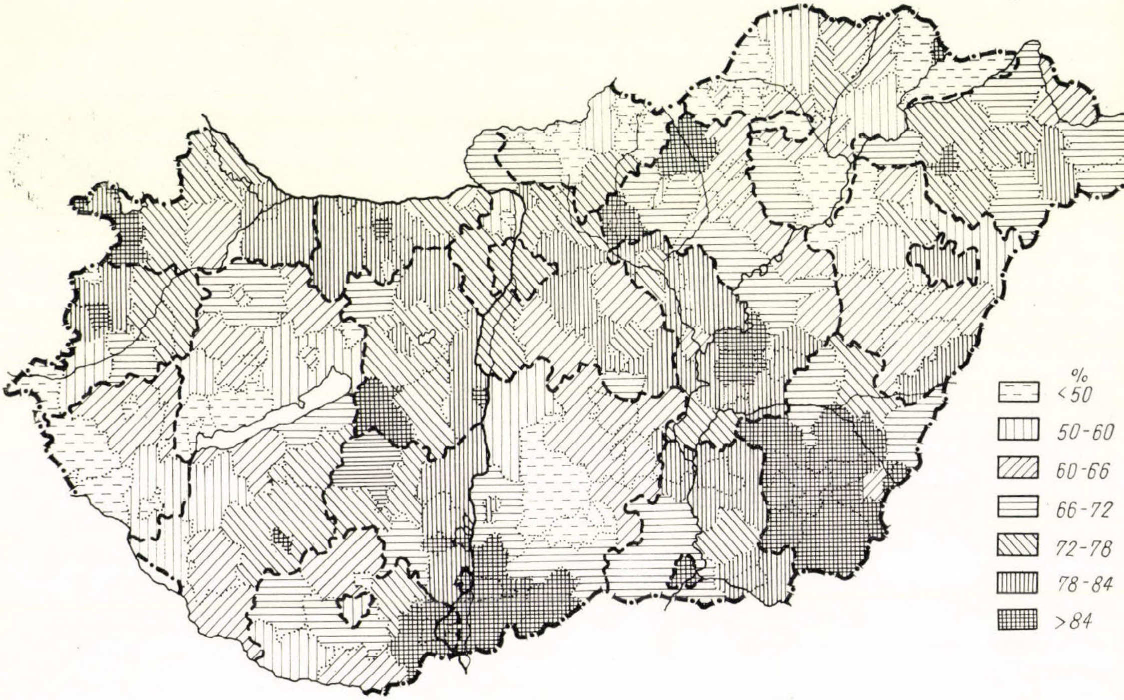


FIG. 2. Percentage ratio of the arable fodder land to primary fodder-growing area, 1960

The proportion of barley is 11.4%, while that of oats is rather insignificant: 3.2%.

The crop percentage of roughages is substantially lower than that of the coarse grains: 21.9%. Of the roughages, lucerne is most important: it represents 6.5%, while green maize and silo maize is 4.7% and red clover 3.9% of the main fodder-growing area.

Of all the fodder crops, coarse grains furnish the greatest nutritive value. Their yield per cadastral yoke is 10 q in starch units. The by-products raise this value to 14.1 q. Roughages and the soft fodders yield, on the national average, 7.7 q, meadows and pastures 4.9 q per cadastral yoke in starch units. As regards protein render, the roughages are first. 1 cadastral yoke of rough and soft fodder crops yields 1.46 q protein, while coarse grains as well as meadows and pastures furnish 0.95 q/cad. yoke.

As was shown by the structure of the fodder-growing area, the major part of fodder basis is furnished by arable land. 79.9% of the starch and 71.3% of the protein content derive from the principal fodders raised on arable land. One should not, however, disregard the nutrients gained from the natural fodder-growing areas, which also have a marked part in the protein

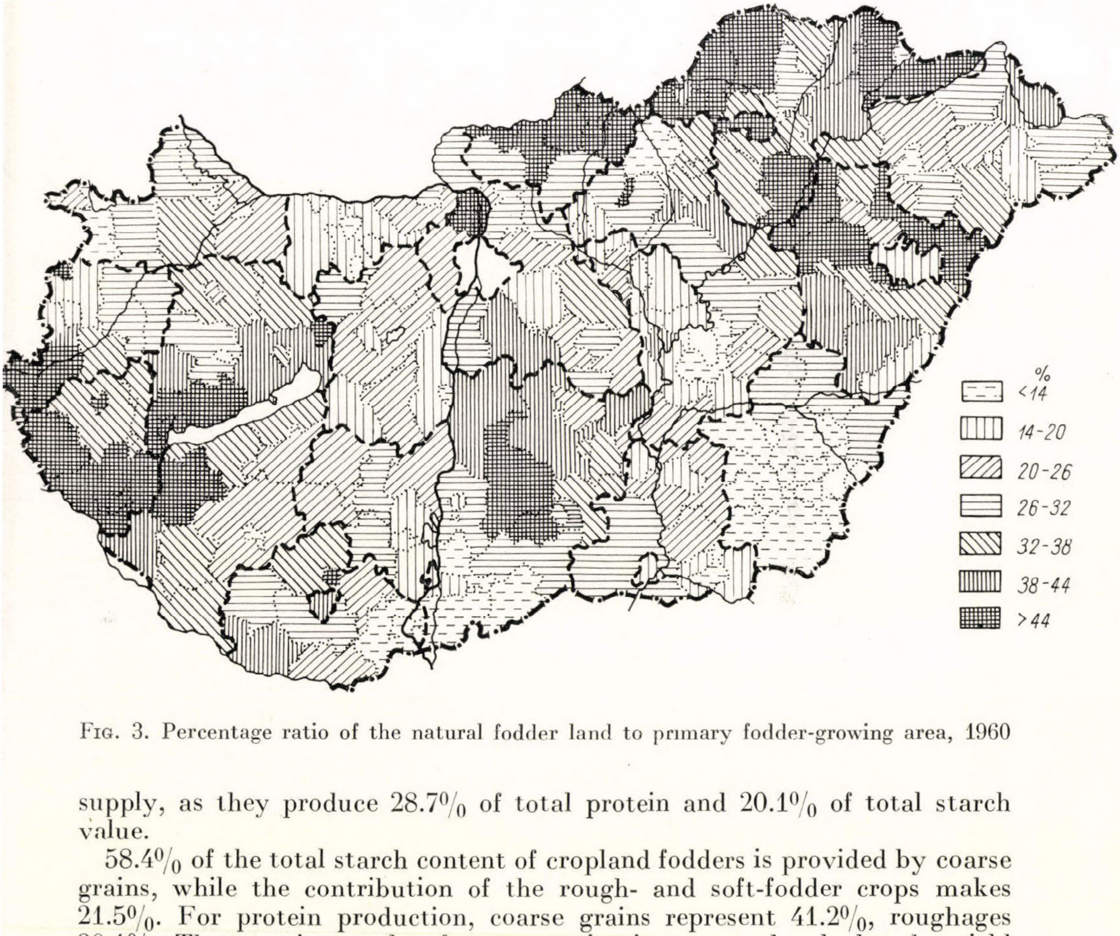


FIG. 3. Percentage ratio of the natural fodder land to primary fodder-growing area, 1960

supply, as they produce 28.7% of total protein and 20.1% of total starch value.

58.4% of the total starch content of cropland fodders is provided by coarse grains, while the contribution of the rough- and soft-fodder crops makes 21.5%. For protein production, coarse grains represent 41.2%, roughages 30.1%. The protein supply of coarse grains is surpassed only by the yield of cropland roughages and soft fodder, and by the coupled yields of meadows and pastures.

The highest amounts of starch values deriving from cropland fodder are produced in the South-East Great Plain, the northern part of the Danube—Tisza Midregion, a section of the Central Tisza Region, the Nyírség, and in the north-western and eastern Transdanubia (Fig. 5). In these areas the cropland fodders furnish in most cases 80 to 90% of the total starch output, in some districts the figure is still higher. However, with regard to strarch output in the rest of the country, it is again the natural fodder-growing area that has come to prevail. In North Hungary (counties Borsod, Nógrád) and Transdanubia (counties Zala, Veszprém and Somogy) more than one third, in some sectors nearly the half (about 34 to 45%) of the total starch value derives from the produce of meadows and pastures, and this is undoubtedly

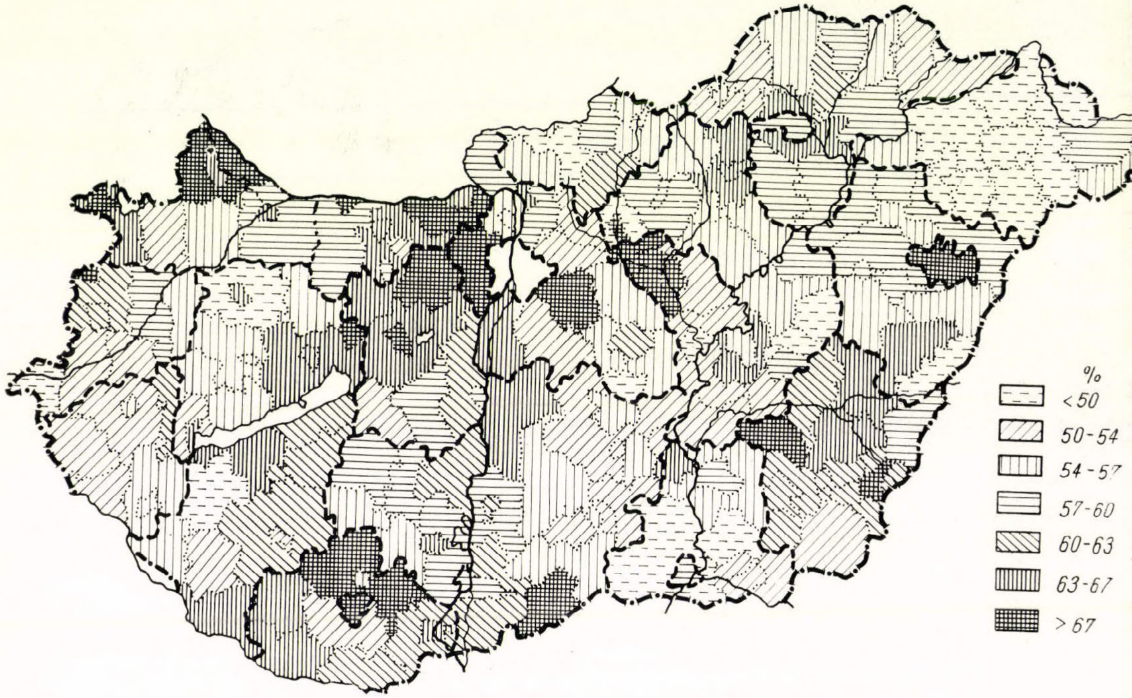


FIG. 4. Percentage ratio of the arable fodder land to total arable area, 1960

a very high value. A high percentage (over 25 to 45%) applies also to the produce of the southern parts of Transdanubia and of the Danube—Tisza Midregion, the Mátra Region and some areas of the Trans-Tisza Region. The protein production shows a similar areal distribution.

The starch content of roughages and coarse grains greatly differs from region to region. The largest contribution of coarse grains to total starch value is found in some areas of the Great Plain (in the northern and south-western parts of the Danube—Tisza Midregion, the Central Tisza Region, the south-eastern and north-eastern parts of the Great Plain) as well as in eastern Transdanubia (Fig. 6). Their percentage averages 60 to 75%. The vast majority of the coarse-grain nutrients is, naturally, furnished by maize; but also noteworthy is the barley producing area, forming a wide belt in the western half of the Trans-Tisza Region, on the riverine of the Tisza, in the surroundings of the capital and on the riverine of the Danube. It furnishes about 15 to 20% of the starch value of all the principal products. The supply of coarse grains is important in the other parts of the country, too, and it is only in the western Transdanubia (counties Vas, Zala, Veszprém) and in North Hungary that this contribution to the total starch value falls short of 45%. In these areas, too, it is the maize that predominates, but in North Hungary and in the Little Plain barley is also important. In western Trans-

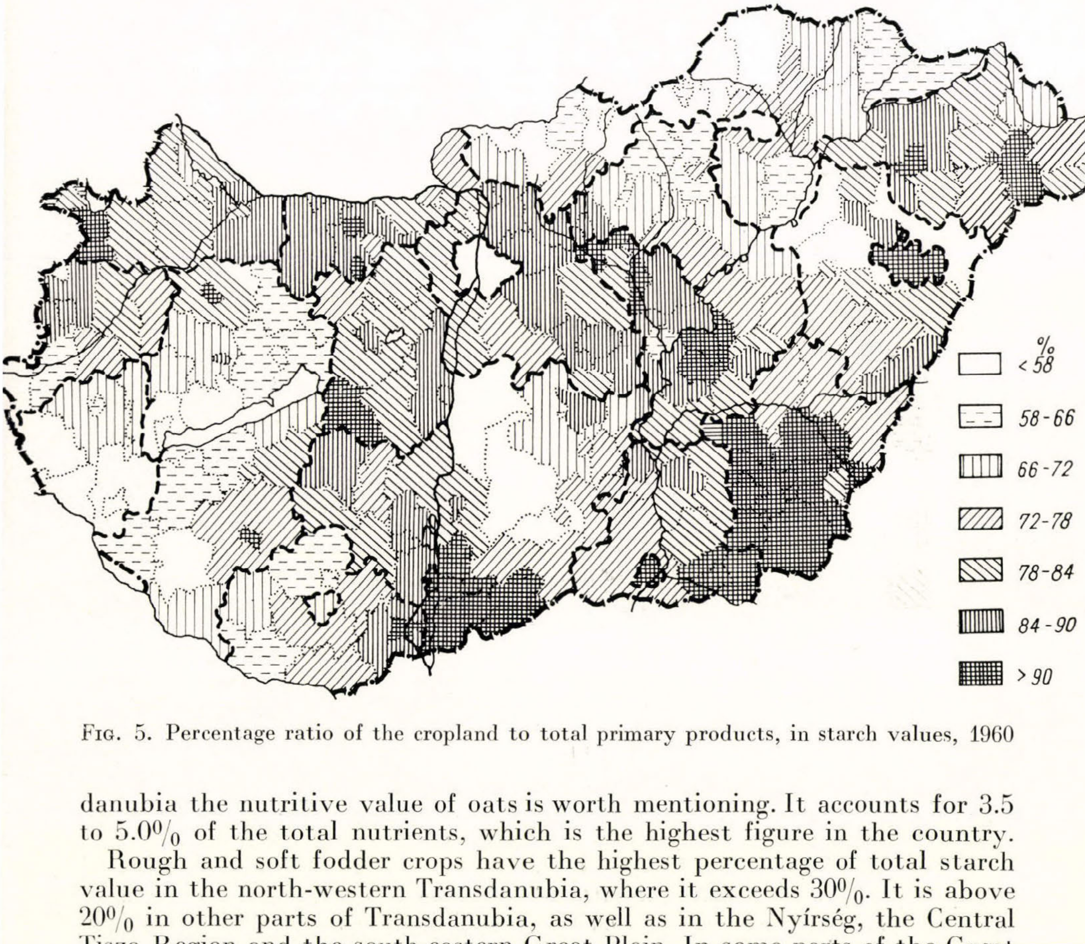


FIG. 5. Percentage ratio of the cropland to total primary products, in starch values, 1960

danubia the nutritive value of oats is worth mentioning. It accounts for 3.5 to 5.0% of the total nutrients, which is the highest figure in the country.

Rough and soft fodder crops have the highest percentage of total starch value in the north-western Transdanubia, where it exceeds 30%. It is above 20% in other parts of Transdanubia, as well as in the Nyírség, the Central Tisza Region and the south-eastern Great Plain. In some parts of the Great Plain (central part of the Trans-Tisza Region, Danube—Tisza Midregion) and in North Hungary, it is generally below 20%. Of the rough and soft fodder crops, the greatest starch value is yielded by green and silo maize which accounts for nearly one tenth (9.5%) of the total starch value. The green maize and silo maize make the bulkiest contribution to the fodder basis in north-western Transdanubia, with a percentage of about 12 to 20%.

Although rather widespread, they are not so important in the other parts of Transdanubia (except its south-western half) and in the Great Plain, for there they furnish only 8 to 15% of total starch value. They are least important in North Hungary, in a part of the Nyírség and in some areas of the Danube—Tisza Midregion, where their ratio is as low as 3 to 8%. The contribution of lucerne to total starch value is the second in the table (4.2%); it is followed by the red clover (2.8%). Both are voluminous items

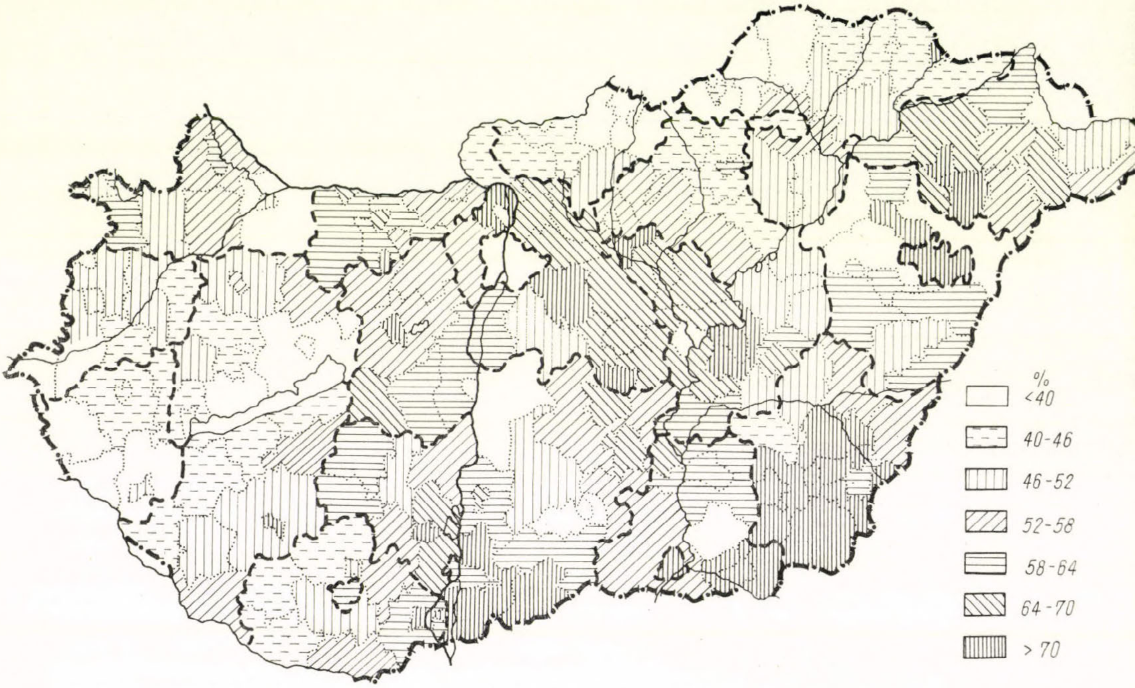


FIG. 6. Percentage ratio of coarse grains to total primary products, in starch values, 1960

of the fodder basis. Their growing areas are rather isolated from each other, owing to physical conditions. In the eastern half of Transdanubia, the lucerne predominates, while in the western half the red clover prevails. Red clover predominates in North Hungary, where its share of total starch value (4 to 10%) exceeds that of the lucerne (2 to 6%). However, in the Great Plain, particularly in the Danube—Tisza Midregion and in the south-eastern parts, the lucerne is far ahead of the red clover in starch content.

The starch yields of rough and soft fodder crops and meadows and pastures largely influence the structure of the livestock, since they form the basis of cattle-breeding. These roughage crops provide much more than half (about 54 to 65%) of the total starch value in the south-western and central parts of Transdanubia and in the Central Mountains of North Hungary; accordingly, the concentrates have a subordinate role there. These figures, however, can be related to the regions mentioned and to certain other districts only (Fig. 7).

The starch percentage of roughages is high enough (about 50%) also in the foreland of the Central Mountains of North Hungary, in the northern half of the Central Tisza Region and in Transdanubia. Hence the fodder produce of these areas promotes cattle-farming. However, the major areas of the Great Plain and in the Mezőföld contribute less than 45% of the total roughages, so there pig-breeding comes into prominence.

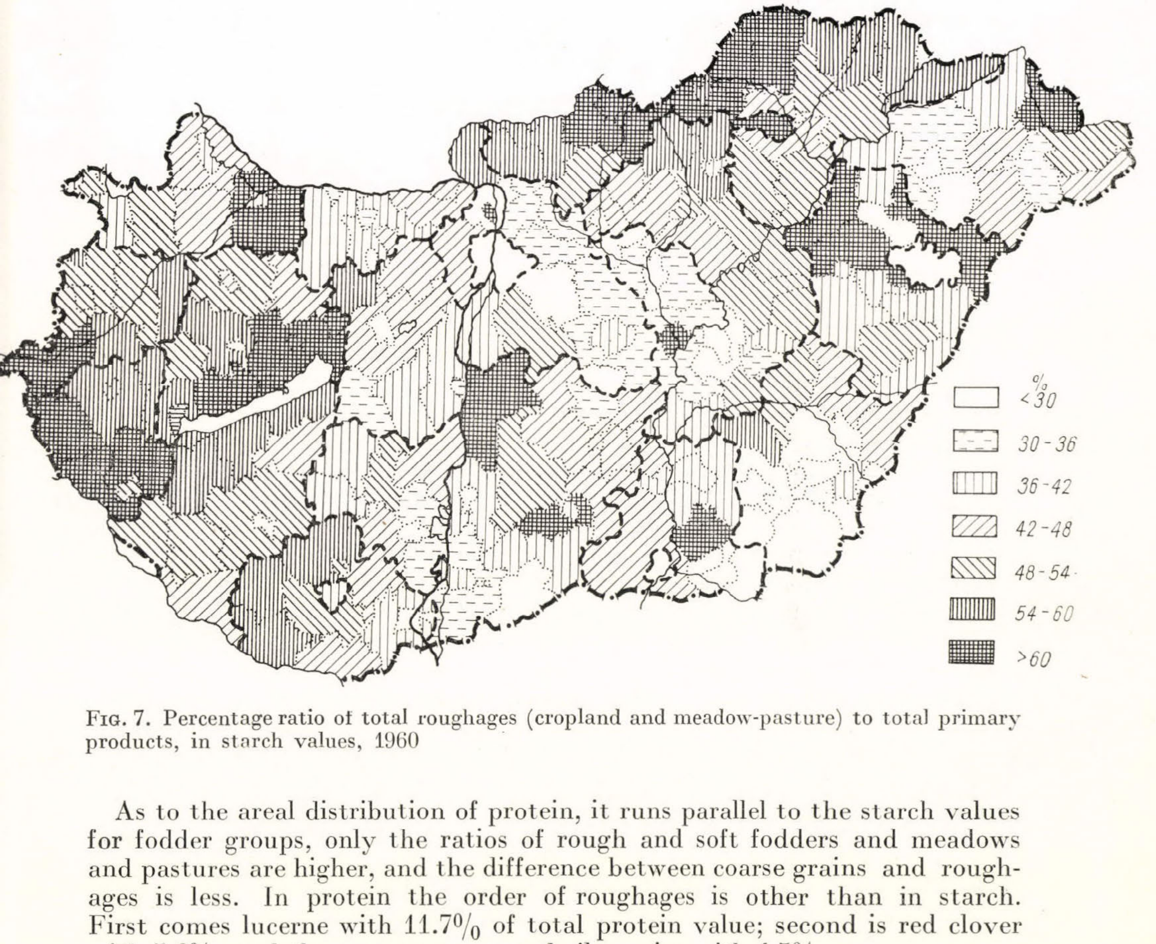


FIG. 7. Percentage ratio of total roughages (cropland and meadow-pasture) to total primary products, in starch values, 1960

As to the areal distribution of protein, it runs parallel to the starch values for fodder groups, only the ratios of rough and soft fodders and meadows and pastures are higher, and the difference between coarse grains and roughages is less. In protein the order of roughages is other than in starch. First comes lucerne with 11.7% of total protein value; second is red clover with 5.6%, and then comes green and silo maize with 4.5%.

Fodder balance

The deficiency of protein and, to a lesser degree, that of starch supplied from the primary growing areas, has a depressing effect on stock-farming. The shortage of protein is responsible for the slow growth of animals, the low yields of animal products, inadequate utilization of fodder. So the production cost is very high, and stock holding is rather unprofitable. The grave situation of foraging is shown by the fact that the principal products cannot meet the needs either for starch value or for protein. Starch requirements are $85^0/_0$, and protein $81^0/_0$ of the total need. Accordingly, it is highly essential to exploit the by-products, which furnish nearly a quarter of total starch value and roughly one sixth of the protein value. Of course, the data with regard to these secondary supplies are highly uncertain.

As regards total protein, there is a deficiency of $4^0/_0$ on the average, worst felt in the western part of Transdanubia and in the Great Plain. The total starch value of principal crops and by-products on the national average shows $11^0/_0$ surplus over the requirements, and only the north-eastern half of the Trans-Tisza Region and the surroundings of the capital and county Zala have deficiencies varying from 10 to $20^0/_0$.

The degree of foraging is actually lower than shown by the national balance, since only the requirements of cattle, pig, horse and sheep stocks have been taken into account. Additional consumption is required by the poultry, which is kept almost entirely on coarse grains (about 6 to $8^0/_0$ of the fodder basis). Other animal species (buffalo, donkey, mule, goat, etc.) must also be included, though their needs do not weigh much on the fodder scale. Considering the above data, we can state that there is no surplus starch, and the deficiency of protein seems to be well above $4^0/_0$.

A simple comparison of total needs with total products cannot reveal the actual situation, for fodder production is not determined by the special needs of the various animal groups. This is the reason why some fodder crops are produced to excess, while others are underproduced, and the surplus products — e.g. a considerable part of the concentrates — are left unused. Accordingly, the need for protein is more serious than seems to be indicated by the total protein value produced.

Reliable information on the fodder basis can be obtained only by examining the needs of each animal species for each fodder group. Such an examination proves that the national livestock of present composition requires $57.3^0/_0$ of its total nutrients from rough and soft fodder crops, and $42.7^0/_0$ from coarse grains. Of course, divergencies from the national average can be seen from region to region according to the kinds of stock. In the western Transdanubia, the Central Mountains of North Hungary and the Nyírség areas, developed cattle-breeding demands a good deal of roughage and soft fodder, while in the Great Plain and in the eastern Transdanubia a more prolific pig-holding primarily requires the concentrates (Table VII).

By figuring the special needs for each particular fodder group, the deficiency will be still further clarified. The concentrates meet the needs for starch on the national average; moreover, a surplus of $16^0/_0$ may be reckoned with (or 8 to $10^0/_0$ if poultry is taken into account). In some areas, however, such as the northern Trans-Tisza Region, Csongrád and Bács counties and the southern and south-western Transdanubia, the concentrates show a deficiency of 16—$30^0/_0$ (Fig. 8). In the major part of these areas coarse grains are largely utilized, as beside a well-developed pig-breeding poultry-farming is prominent. The deficiency of concentrates is over $20^0/_0$ in the Central Mountains of North Hungary.

TABLE VII

Starch demand and supply according to fodder groups in 1960 percentages

	Starch demand from		Supply of starch from		
	coarse grains	rough and soft fodder crops	coarse grains	rough, soft fodder, meadow-pasture	Total (including by-products)
Baranya	43	57	128	75	124
Fejér	46	54	155	54	145
Győr	36	64	177	83	151
Komárom	38	62	161	63	131
Somogy	40	60	125	74	122
Tolna	45	55	154	68	142
Vas	33	67	118	63	103
Veszprém	33	67	131	75	117
Zala	34	66	95	59	89
Total Transdanubia	39	61	137	71	125
Bács	46	54	104	57	103
Békés	49	51	121	47	114
Csongrád	48	52	85	42	84
Hajdú	55	45	65	55	80
Pest	43	57	148	57	127
Szabolcs	39	61	87	39	79
Szolnok	46	54	127	68	125
Total Great Plain	47	53	100	52	100
Borsod	35	65	119	63	104
Heves	38	62	159	72	136
Nógrád	35	65	128	75	117
Total North Hungary	36	64	131	67	114
Total Hungary	43	57	116	61	111

The country-wide surplus can compensate for regional deficiencies, as surplus concentrates are produced by northern and eastern Transdanubia as well as the Central Tisza Region and the foreland of the Central Mountains of North Hungary. The livestock of these regions does not consume all the fodder harvested, so a part of it becomes marketable to meet the demands of other areas facing fodder shortage. In contrast to the balanced resources of coarse grains, there is a very great deficiency of roughages. On the national average, the total nutrients of rough and soft fodder crops and those of meadows and pastures cover but 61.5% of the total demand for starch. Particularly great is the deficiency in the Great Plain, chiefly in the Nyírség, the major part of the Danube—Tisza Midregion and the south-eastern Great Plain (Fig. 9).

The principal roughages meet, at most, half the requirements. Hence arises a very strong impediment to cattle-farming. The situation is not much better in western Transdanubia either, although this region is prominently cattle-breeding. The deficiency is about 40 to 50% in relation to the principal roughages harvested there. The insufficiency of principal roughages is to be felt throughout the whole country, as the amount needed is nowhere adequate. The supply of livestock is badly affected by the fact that a great deal of inferior by-products have to be used for foraging, which results in low yields of the animals. The total starch value of rough and soft fodder crops and by-products is more than enough to cover the requirements on the national scale, as it shows a surplus of about 7%. Nevertheless the fodder is insufficient

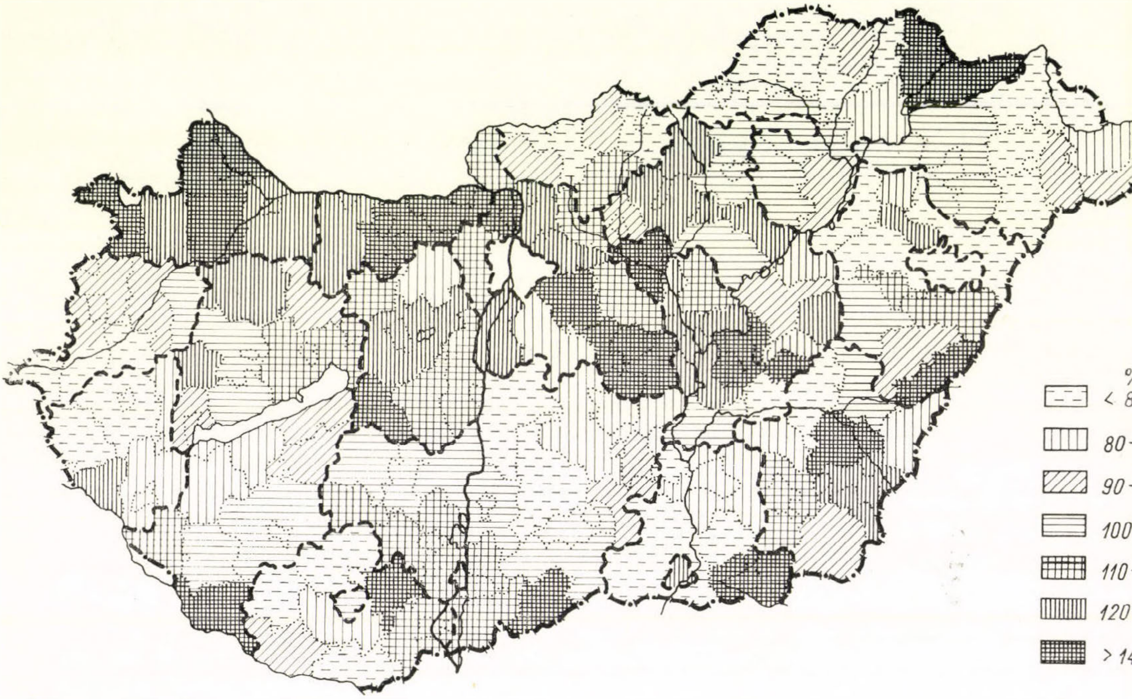


FIG. 8. Percentage ratio of the grain crops to total starch needs of the livestock, 1960

in some areas, particularly the north-eastern part of Hungary, county Csongrád and the western border of Transdanubia.

Of course, this broad outlining of fodder balance can provide only approximate information on the present state of things. Further development of data will be influenced by numerous factors. For example, an exact survey of fodder requirements involves a detailed examination of the distribution of the animal species by age and sex and the technique of their utilization. In fact, the animal species show widely varied needs for fodder as regards quantity, quality and composition. It is not possible to survey to what extent some species — especially sheep and poultry — draw on the fodder basis, or to what extent wayside pastures, stubble-fields, household wastes, etc. may contribute nutriment to their feeding. Moreover, a precise fodder balance presupposes a knowledge of data on the yield of a number of fodder crops, for lack of which only rough estimations can be made. No data are available as to the aftercrops and mixture crops. The amounts of by-products used for foraging (maize stalk, fodder straw, leaves of turnip, etc.) are unknown. The development of the fodder basis is largely influenced also by the method of fodder treatment (time of harvesting, drying, storing, etc.).

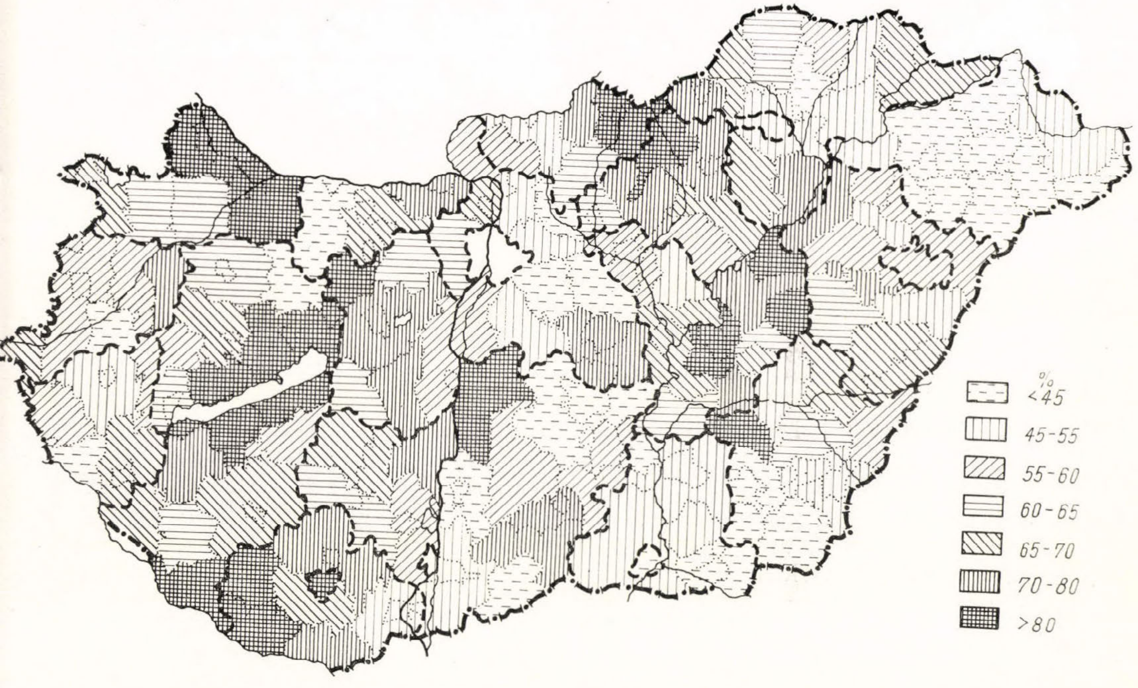


FIG. 9. Percentage ratio of the rough and soft fodder crops to total starch needs of the livestock, 1960

As the possibilities for enlarging the fodder-growing areas are limited, the fodder basis can be augmented only by a modern fodder economy. This holds particularly true for the roughages which presently show the greatest deficiency and least development. Fodder in the Great Plain might be improved, first of all, by irrigation. The propagation of fodder crops yielding the highest starch value and greatest amount of protein is not a matter for indifference, either. The protein value could be increased by intensifying the production of lucerne and red clover, for these crops yield most protein per cadastral yoke: 1.91 q or 1.54 q, respectively. A large-scale production of green and silo maize would be motivated by their starch value (16 q) highest of all the fodder crops. As their protein yield also exceeds 1 q/cad., their yield of total nutrient content is superior even to that of grain maize. The pronounced scarcity of starch in roughages could be largely compensated by a more intensive production of green and silo maize. Mangel production has been neglected recently, because it is a labour-absorbing plant. This crop furnishes a considerable amount of nutrients, notably 10 q of starch and 1.17 q of protein per cadastral yoke, which is higher than that of most roughages, or of barley and oats, to speak of coarse grains.

A modern fodder economy may develop numerous possibilities for reducing and eliminating the deficiency. For example, the average yield of lucerne can be increased by about 5 q/cad., without any particular investment, by up-to-date fertilization, by weed-killing, parasite control and harvesting in due time. This results in a surplus starch of about 1.5 q and in a surplus protein of about 0.5 q. Accordingly, the surplus crop of 1,000 cadastral yokes of lucerne would be sufficient for the annual needs of 90 to 100 head of cattle, or for the production of about 700,000 to 800,000 liters of milk.

Irrigation offers still wider possibilities. Lucerne under irrigation would yield 40 q hay per cadastral yoke, i.e. double the present yields or even more. This would result, in turn, in such a high increase of nutrients that 1,000 cadastral yokes irrigated for lucerne could supply about 350 to 380 more cattle. The irrigation of roughages, however, is in a rather initial stage as yet; large-scale irrigation has just started.

An improvement, however, can be achieved by increasing the quantity and improving the quality of the roughages. The leguminous crops lose a great deal of their nutritive power after harvest, when dried in rows, or in the course of transport and stacking. The losses may amount to 12—15% because of the fall-off of leaves, the most precious parts of the plant. By drying on stands or by means of airing, the leaf waste could be avoided in part, and the protein value could be increased by about 2%, the starch value by about 6%, which would make a surplus protein of about 36 to 40 kg and a surplus starch of about 100 to 120 kg per cadastral yoke.

The greatest resources of stock-farming are found in the natural fodder-growing areas, because their rich and cheap yields can be multiplied by modern methods without expensive investments. A harvest of a pasture costs hardly more than half of what it does in a lucerne plot. But by irrigation and fertilization, pastures may result in a grass yield of 100 to 200 q, instead of the present 20 to 25 q. Between 1947 and 1960 the area of meadows and pastures under irrigation was extended six times and in 1960 it reached 26,000 cadastral yokes, which, however, represents but 1.1% of the total natural fodder-growing area.

Irrigation of natural fodder-growing areas is practiced, first of all, in the Great Plain. 61.4% of the meadows and pastures have been put under irrigation here, while the ratio of Transdanubia irrigation is 34% only. Irrigation, however, has not been evenly spread throughout the country. It is fairly well developed in the Central-Tisza Region and the central part of the Trans-Tisza Region, where 42% of the total irrigated meadows and pastures is found, i.e. more than in the whole of Transdanubia. Of the total irrigated natural fodder-growing areas of Transdanubia, 57% is situated in the Little Plain, precisely in county Győr-Sopron.

On the whole, the natural fodder-growing areas have been brought under irrigation only to a small extent as yet. On a national scale, only 16.3% of total irrigated land are meadows and pastures. However, on the Little Plain about a half of the total irrigated area and about one-third of the central part of the Trans-Tisza Region that is irrigated, are meadows and pastures.

Poor water reserves in some dry areas may hamper the expansion of irrigation plants, but even so the conditions there could be more fully exploited, for the produce of natural fodder-growing areas can be increased not only by irrigation, but also by fertilization, weed-killing, planting of trees, rotational grazing. In other words, all the ways and means of up-to-date and rational meadow- and grassland-farming are to be taken into consideration, in order to develop a modern fodder economy, which is a precondition of a more productive stock-farming and more intensive agriculture.

Bibliography

Asztalos, I. (1963) Az állattenyésztés területi megoszlása Magyarországon (Areal distribution of animal husbandry in Hungary), *FK*, Budapest

Asztalos, I., Sárfalvi, B. (1960) A Duna—Tisza köze mezőgazdasági földrajza (Agrogeography of the Danube—Tisza Midregion), Akadémiai Kiadó, Budapest

Bernát, T., Enyedi, Gy. (1961) A magyar mezőgazdaság termelési körzetei (Production regions of agriculture in Hungary), Mezőgazd. Kiadó, Budapest

Hajas, J., Rázsó, I. (1955) Mezőgazdaság számokban (Agricultural statistics), Mezőgazd. Kiadó, Budapest

Kiss, A. (1958) Állattenyésztésünk belterjességének alakulása az elmúlt száz évben (1857—1957) [The intensification of cattle-breeding during the last hundred years in Hungary (1857—1957)], *StSz*, Budapest, nos 1—2

Manczel, J. (1962) Szarvasmarhatenyésztésünk és takarmány termelésünk helyzete és tájbeli eltérései (Cattle-breeding and fodder production and their regional differences in Hungary), Akadémiai Kiadó, Budapest

Pécsi, M., Sárfalvi, B. (1962) Die Geographie Ungarns, Corvina, Budapest

Sipos, J. (1958) A rét és legelőgazdálkodás helyzete és feladatai (The state and objectives of grassland and pasture farming), *AgT*, Budapest, no. 6

POSSIBILITIES OF AGRICULTURE UNDER IRRIGATION IN THE NYÍRSÉG

by LÁSZLÓ SIMON

According to the long-term national plan, agricultural production in Hungary is to be raised in 20 years by two to two and a half times its 1960 output. Thus the rate of development will be almost ten times quicker than that of the last thirty years, which were adversely affected by the war and erroneous economic policy. The plan seems to be well conceived and feasible, and there is no doubt that the socialist agricultural workers will fulfil this task. However, such an objective demands that both science and economic planning make parallel efforts to find and apply "qualitatively" new methods. Many resources untapped as yet are to be explored by science and utilized in practice. Among them, the extension of agriculture under irrigation plays an outstanding role.

The long-term plan projects the irrigation of 1.2 million hectares. The feasibility of this plan is completely supported by the most essential considerations of science. However, it does not encompass the irrigation of the two great lowland sand areas of Hungary, the Sand Ridge of the Danube—Tisza Midregion and that of the Nyírség, each having areas of 250,000 ha. These two elevated sandy landscapes lie about 25 to 50 m above the mean level of the principal Hungarian rivers (Danube and Tisza) and have surface water systems with low discharge. Nor can water be feasibly supplied to the central parts, from the big rivers bordering these regions. The possibilities for water production from the inner natural drainage systems are extremely limited, permitting irrigation of a few thousand hectares only. At the same time, these sand regions are intensively farmed and are the main centres of a world-famous vini- and fruit-culture and also of tobacco production (the Nyírség).

Because of the climatic conditions of Hungary it is reasonable to irrigate these sandy areas with their intensive cultures, not so much for increasing yields as for eliminating the ups and downs of harvest yields. And if the surface waters offer only very limited possibilities for irrigation, the subsurface waters, chiefly the artesian ones, can yield water enough for the intensive crops. In fact, both sand regions are extensive alluvial fans of the major rivers of the Pleistocene period. So the gravelly and sandy sediment beds must contain water of sufficient quantity and quality to allow a tube-well sprinkler type irrigation.

In Hungary, water economy is managed by special organizations and scientific institutes which, however, make a careful, detailed exposition only after preliminary surveys have indicated possibilities for irrigation of arable lands and meadows. A many-sided economico-geographical approach to the problems of irrigating intensive cultures in the Nyírség has been undertaken by the author of this paper, relying on earlier partial research studies.

The peculiar economic conditions of the Nyírség

The Nyírség is a distinct mesolandscape of north-eastern Hungary. However; the Rétköz, though physiographically separated, must be attached to the Nyírség for economic and administrative reasons and also because the hydrogeological unity of the Rétköz and the Nyírség is indisputable. This has determined the main scope of our investigations, still further complemented by the Szatmár-Bereg Plain, which forms a broader hydrogeological unit with the Nyírség.

Our objective is to prove that if the areas allotted to apple growing by the long-term plan were put under irrigation, it would be possible to amortize the investments by nearly 500 million Fts per year. It should be noted here that the costs involved would be more quickly amortized and would not be less efficient than a similar industrial investment.

In the long run, the most important branch of production is represented by winter apple. The long-term plan envisages an expansion of its growing area to a round 60,000 ha, hence the commercial apple orchards will be nearly four times larger in 1980 than they were in 1960. The gross production value of 40 to 70 thousand Fts per hectare, often obtainable at present, can by no means be regarded as a final limit. But even with this range of values, the planting of about 45,000 ha of apple orchards may be made to double the gross production, once the newly planted trees will have reached their fully productive age. All the other branches of agriculture taken together cannot approximate this colossal output. At the same time, apple also has the greatest range of crop fluctuations of all the fruit cultures. For instance, the record apple production of 1959 amounted to 85,000 tons. The market data, which are more reliable than the data of production, show the tonnages as follows: 1955: 55,000, 1956: 31,0C0, 1957: 43,000, 1958: 38,000, 1959: 85,000, 1960: 32,000.

Such a great crop fluctuation renders every plan uncertain under present conditions. If such a pronounced fluctuation is to be calculated for 60,000 hectares, a tolerance of 30 to 40% per year would have to be allowed in the total agricultural production of the region, and divergencies of 8 to 12% in Hungary's total exports of fresh agricultural products.

This unpredictable crop fluctuation is mainly due to the uncertainty of rainfall. The optimum amount of precipitation required for apple growth on loose soils is 850 to 950 mm a year. However, the annual average in our region is only 600 mm: in exceptional years it may amount to 900 mm, while in years of drought it is hardly 300 mm. The rainfall of the growing season exhibits similar fluctuations. According to the set of data covering a 100 years collated by Berényi, rainfall averages 310 mm, with a maximum of 660 mm and a minimum of 90 mm. The rainfall of the growing season is 250 mm, with a probability rating of 75%. Such deficiencies are compensated for only in areas with high-seated groundwater table, where the roots penetrate, on the average, to a 60—100 cm depth and can thus directly take up groundwater, without any damage to their transpiration. Such conditions, however, are not to be found in the Nyírség, as there the water table lies on the average at a depth of 2 to 3 m below the surface, and in the eastern Nyírség it lies even deeper. Hence, the insecurity of fruit produce is largely due to the extremely varied distribution of precipitations.

We may refer to an example, which for the moment can be regarded as normative. The state farm at Nyírlugos has been experimenting with apple production under conditions of irrigation on 30 ha, since 1959. The orchard has been given a water cover corresponding to 90 mm of annual rainfall, although the supply of water is obtained under very disadvantageous hydrogeological conditions, from a depth below 100 m and with a low [16 l/min/m] specific yield. The irrigated plot in some years yielded 80 q/ha more and, on the average for four years, by 50 q/ha more, than the dry-check-plot. The net value of the increase is from 7,000 to 9,000 Fts/ha, which is substantially higher than the average net value obtained from 1 hectare of agricultural land. At the same time, the level of production was secure and stable. Encouraged by these results, the state farm is going to put an additional 60 hectares under experimental irrigation.

The problem of stock-farming, more precisely that of its fodder basis, has been shown, in a paper which appears earlier in this book, to be one of the most serious problems of Hungarian agriculture. In Hungary, where the growing area per one agrarian breadwinner is one of the smallest in the world (2.4 ha, i.e. one fifteenth of that pertaining in the Soviet Union), the chief endeavour is to obtain the highest possible production value per areal units. Under the present conditions, however, the production value of fodder-growing (which occurs on nearly 60% of the total agricultural area) is very low—particularly as compared with the hand-labour input—in terms of end-products, i.e. animal products; indeed it is considerably lower than the averages of other agricultural branches. The rate of fodder production could be accelerated only by means of intensive meliorations, namely irrigation, which, in turn, is not feasible unless the prime costs are low, i.e. the cost of irrigation for 1 ha must not exceed 3,500 Fts a year, even by a water cover average of 250 to 300 mm. Such possibilities exist in the Nyírség only in those areas where irrigation can be ensured directly from surface waters. Artesian and groundwaters may be used for experimental irrigation of fodder crops only at certain places in the northern zone and on about 60,000 hectares in the Szatmár-Bereg Plain. This is the main reason why the latter area unit — which possesses an improved stock-farming system anyway — has to be regarded as pertaining to the Nyírség. We are of opinion that this relationship will be accepted as a decisive factor in developing the specialization of the area.

Irrigation from surface waters

(1) These possibilities are not insignificant, but their areal distribution is very unequal. While the Szatmár-Bereg Plain is densely intersected by rivers (Szamos, Tisza, Kraszna, Túr), the Nyírség is only bordered by the Tisza, which gives it a geographical frame.

According to the general irrigation project prepared by the Upper-Tisza District Water Authority in 1962 — with a view to a probability of 85%

discharges in the critical month of August—irrigation is feasible within the following frame of references:

(A) Running Waters

Stream	Site of cross-section	Water reserves in August by a probability of 85% m^3/sec	Irrigable area in hectares
Tisza	Záhony	95.00	49 706
Szamos	Olcsvaapáti	25.00	36 324
Kraszna	Vásárosnamény	0.16	550
Lónyai Canal	Vencsellő	0.084	300
	Total		89 280 ha

(B) Reservoirs

Dead-Channel of the Szamos at Tunyog-Matolcs	0.658	1 682
Reservoir at Székely	0.097	356
Reservoir at Rohod	0.097	356
Reservoir at Vaja	0.156	575
Total	1.008	2 969
Total A + B		92 249 ha

Accordingly, the area irrigable from surface waters totals round 100,000 ha (98% of which is situated on the Szatmár-Bereg Plain). The conditions for water production expounded in the project appear to allow an economical irrigation of the fodder-growing areas, inclusive of large meadows and pastures.

We believe that the surface waters offered in the Nyírség Platform would suffice for the irrigation of an area larger than outlined above, but the construction of reservoirs would cost so much that only intensive cultures, primarily apple, could afford it.

In the centre of the Nyírség Platform the storage of the waters of the canals, the total length of which already exceeds 3,200 km, could offer some additional, though limited possibilities for irrigation. But the storaging raises difficult problems. In general, it is impossible to store water in the natural depressions, for then the water would spread just over precisely those areas for the drainage of which the canal system has been built. In addition, some of the depressions are covered by sziksoils, hence the stored waters would dissolve lots of harmful salts and would saturate the area with them. In addition, building the reservoirs would be very expensive. The construction of sunken reservoirs, considering also the properties of the loose soil (casing with bentonite !), requires additional costs of 40,000 to 50,000 Fts per hectare of the area to be irrigated.

Irrigation for about 7,000 to 9,000 ha can be supplied by means of reservoirs storaging from the canal system. For five years the average discharge of the Lónyai Canal in April makes 2.5 m^3/sec. Assuming a storage sufficient for six weeks at such a rate of discharge, and allowing for 50% seepage- and evaporation-loss in the reservoir, the waters stored would yield a cover 200 mm thick for 7,000 to 10,000 ha of land. The waters of the canals running to the south of the Nyírség watershed may also be used for storage irrigation, although in a substantially smaller area (2,000 to 3,000 ha).

(2) If the surplus waters from the Eastern Main Canal are transferred to Debrecen, some further possibilities for irrigation from surface waters will be available. This problem and its financial requirements were discussed in detail at the round-table conference held at Debrecen in 1962. In our opinion, this project should be carried out by all means. The aqueduct is demanded because of the problematic supply of artesian waters from the basement of Debrecen (see later), the industrial development of the city, and the end-results of irrigation. The resulting water would be supplied properly, not to the area of Nyírség, but to that of Hajdúhát, to irrigate about 3,500 ha of fodder- and vegetable-growing area. The reinforced concrete pipe, starting with a discharge of 3,600 l/sec, might be branched off at Hajdúszoboszló and Ebes, and the rest of the water could be conveyed, at a rate of discharge of about 1,000 l/sec, to Waterworks No. 1 of Debrecen, where the increased capacity would supply drinking and industrial water for several decades; moreover, the Waterworks could also provide water for irrigation, at least provisionally. It must also be pointed out that the water thus supplied for irrigation would be less expensive than that obtained from aquifers. So the system ought to be so constructed that its capacity should suffice for the irrigation of some 3,000 to 4,000 ha of intensive cultures in the sandy areas of Debrecen, which properly belong to the Nyírség-type of sandy soil.

In conclusion, nearly 30,000 hectares of the Nyírség Platform might be errigated from surface waters. This is the upper limit at the present level of angineering, nevertheless such an area if put under irrigation would increase igricultural production by at least 7%.

Irrigation from artesian and groundwaters

On the surface of the Nyírség Platform, lying 20 to 50 m higher than the adjacent marginal troughs, there are only scanty surface streams. The major rivers flow along the edges. Therefore, irrigation waters for the central areas of the Platform can be obtained only from subsurface aquifers.

Although hydrogeological investigations are fairly advanced in Hungary, the preliminary researches carried out in the Nyírség have yielded insufficient data for solving all the irrigation problems there. There are many questions left open, particularly as regards migration and recharge of waters. One conception suggests that the artesian waters of the Great Plain basin together with the sediments enclosing them represent static resources. The inter-connection of the characteristics of the artesian waters with the geological structure was emphasized by many research workers. Detailed studies were made, however, only on the matter of their relationship with the buried Pannonian surface. Consequently, we had to undertake further hydrogeological investigations in order to settle all the open problems of regular relationships. These investigations were at the same time extended to the large Sand Ridge of the Danube—Tisza Midregion, which is similar both structurally and morphologically to the Nyírség. The water yield, pressure, and temperature data of some 5,000 artesian wells and their stratigraphic columns were analysed. More than 90% of the wells tap the Pleistocene sediments, which are the most important aquiferous series. The analyses brought to light some regular relationships which either had been unknown, or had not been substantiated sufficiently.

The chief results are as follows:

(1) Mappings of the pressure conditions of the artesian waters have shown that water pressure is controlled by the deep geological structure rather than by the surface relief. This fact had been emphasized earlier by several Hungarian workers (Sümeghy, Rónai). By pressure conditions we understand all the phenomena connected with the hydrostatic level of the artesian waters, which always lies near the surface, yet exhibits marked differences in depth as compared to the surface. These differences may be as much as 50 to 60 m. Positive pressure conditions are spoken of, if the hydrostatic level lies above the surface (i.e. water is surging up from the tube) and pressure increases with increasing depth, because the water pressure is higher than the hydrostatic pressure. Pressure conditions are regarded as negative, if the hydrostatic level is situated under the surface and the pressure decreases with increasing depth, i.e. if the water pressure is lower than the hydrostatic pressure.

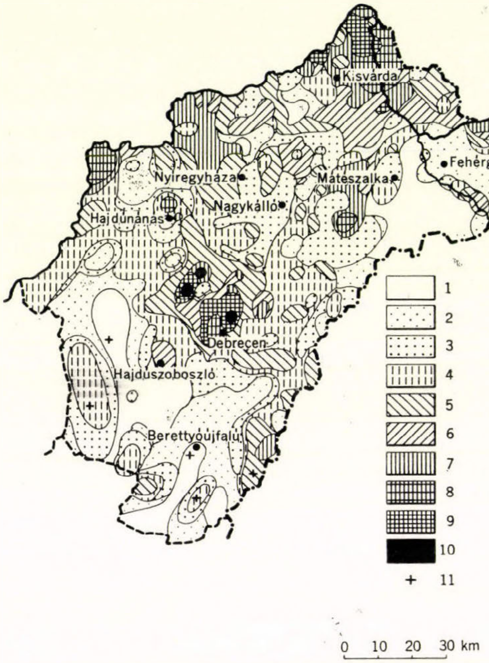
Having compared our detailed pressure maps with the abyssal tectonic maps, and the gravimetric and geomagnetic maps, indicating the position of the deep structures as well as the relief of the deep-seated strata and their lithology, we found surprising correspondences in the finest of details (Figs 1 to 3).

In fact, the reliefs of the basement of the Great Plain basin (made up of buried Mesozoic and Palaeozoic rocks), the eruptiva filling some depressions of the basement, and the various Palaeogenic and Neogenic beds overlying it, are regularly interconnected with the pressure conditions of the waters obtainable from the superimposed strata. The accidents (horsts, ridges, anticlines, etc.) of the basement (or those of the lowermost impervious layer) coincide with negative pressure conditions of artesian waters; whereas the aquifers lying above the deep depressions of the basement (troughs, grabens, synclines) yield artesian waters of high hydrostatic level, mostly with positive pressure conditions. Our cross-sections (Fig. 4) show this relationship even more illustratively than the maps do.

(2) Not only the hydrostatic level, but also the rate of depression necessary for obtaining a given water yield bears the same relationship with the relief of the deep geological structures as mentioned above. In our cross-section (Ebes, Tiszabecs) we have indicated the depression necessary for achieving a yield of 20 l/min through a filter of 1 m. The lines indicating its various trends have essentially the same direction as the lines indicating the trends of pressure variation. Accordingly, in wells located above abyssal accidents

a greater depression must — and can — be produced in order to ensure the same water yield as in wells located above basement subsidences.

When investigating the causes of these relationships, first of all the surface relief has to be thoroughly studied. In doing so, we found the surface relief to be positively involved in controlling the water level. However, this provides



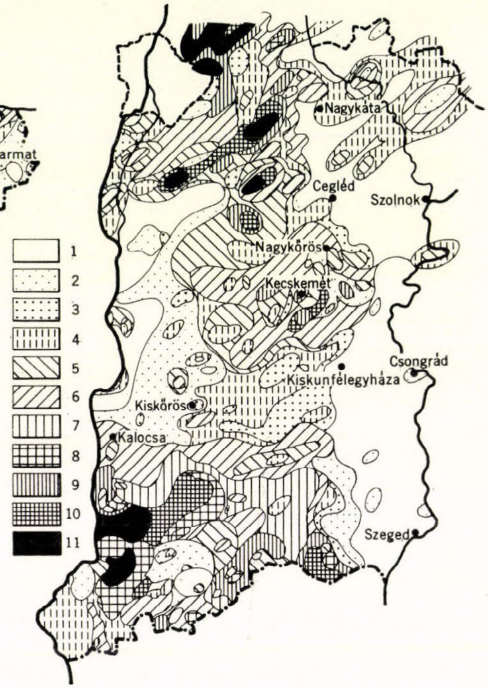


FIG. 1a. Hydrostatic level (in m) of artesian wells, reduced to a depth of 100 m below surface level in the Nyírség (L. Simon)

1 = +5 to 0 ; 2 = 0 to −2 ; 3 = −2 to −4 ; 4 = −4 to −5 ; 5 = −5 to −7 ; 6 = −7 to −8; 7 = −9 to −11 ; 8 = −11 to −15 ; 9 = −15 to −20 ; 10 = below −20 ; 11 = gas-zone water

FIG. 1b. Hydrostatic level (in m) of artesian wells, reduced to a depth of 100 m below surface level in the Danube—Tisza Midregion (L. Simon)

1 = +10 to ±0; 2 = ± 0 to −2; 3 = −2 to −4; 4 = −4 to −5; 5 = −5 to −6; 6 = −6 to −7; 7 = −7 to −9; 8 = −9 to −11; 9 = −11 to −15; 10 = −15 to −20 ; 11 = below −20

a satisfactory explanation only within areas of identical tectonic type (geotypes) and even there in very few cases. We have had to consider Bernoulli's law, governing the movement of all migrating waters. But as will be seen later, water level differences of 20 to 30 m cannot be interpreted by Bernoulli's law, owing to their different order of magnitude. The temperature conditions, however, may give a satisfactory explanation even in this respect. Considering the coefficient of thermal expansion of the water $1.8 \times 10^{-1}/1$ °C), even thermal expansion differences of 15 to 20 m may occur in the Great Plain basin, exhibiting differences in depth greater than 3,000 m and limit values of 10 to 40 m for the geothermic gradient. These differences in thermal

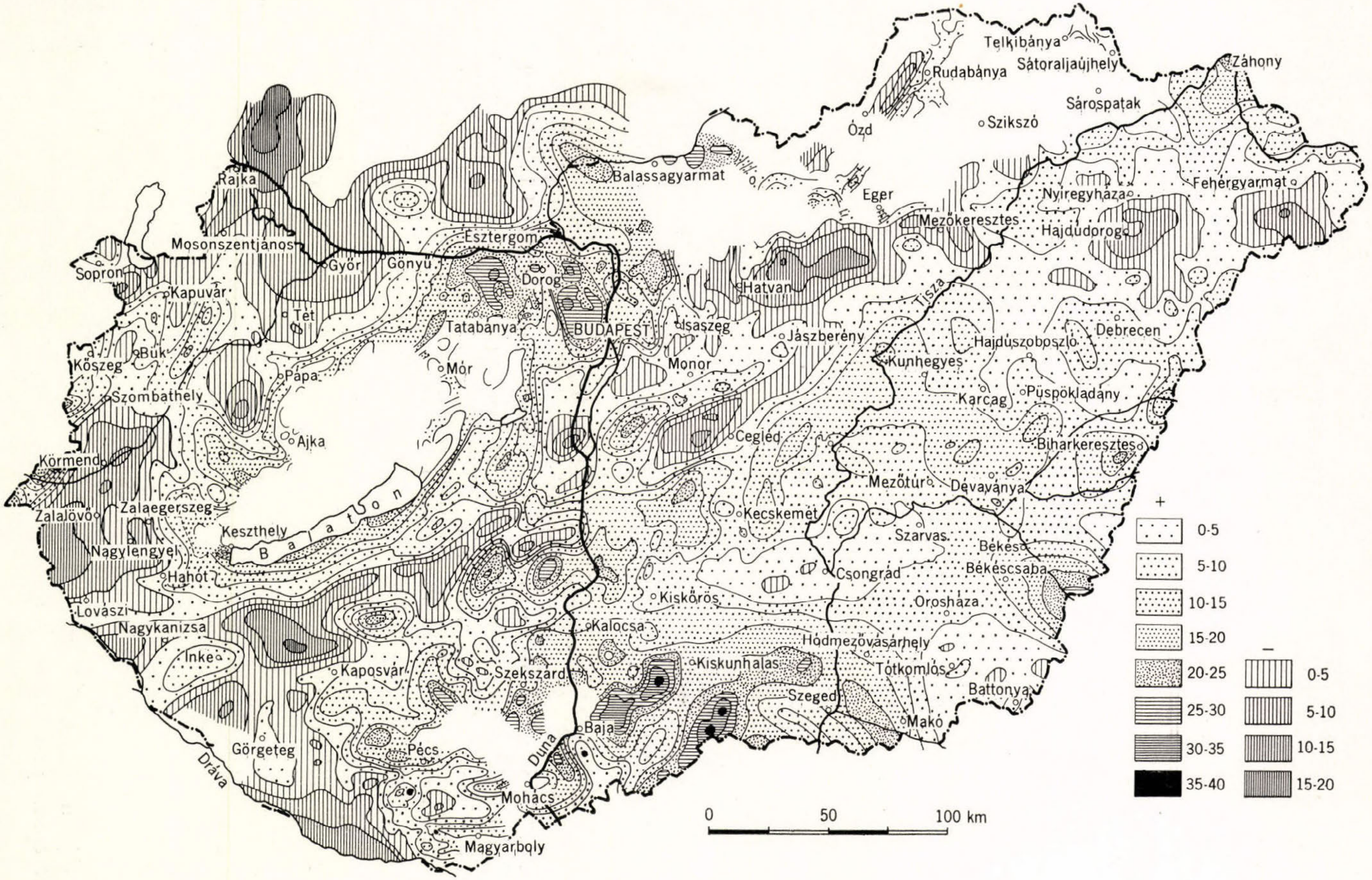


FIG. 2. Synoptic gravimetric map on Bouguer scale (by courtesy of V. Scheffer)

expansion may be increased by differences in vapour tension. Hence, the temperature conditions allow a fairly good explanation of the different heights of the hydrostatic levels. This is only possible, however, if the waters streaming in various strata throughout the Great Plain basin formed a uniform, intercommunicating water system. The correspondence of areas of identical structural types (geotypes) to identical pressure conditions proves, in every case, the unity of the water system.

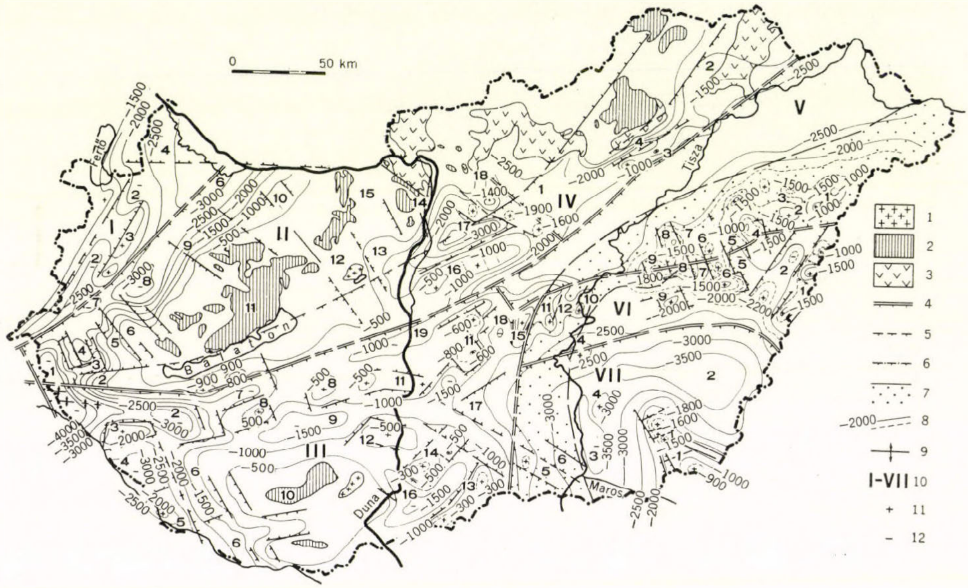


FIG. 3. Tectonic map of the basin areas of Hungary (by courtesy of L. Kőrössy)

1 = Exposures of abyssal structures; 2 = Exposures of basement portions; 3 = Exposed Tertiary volcanites; 4 = First-rank dislocation zones separating major tectonic units; 5 = Second-rank dislocation zones separating graben and horst ranges within a major tectonic unit; 6 = Third-rank dislocation zones; 7 = Limit of the extension of the orogenic flysch formations; 8 = Contour lines of the basement surface; 9 = Anticlines at Lovászi—Budafa; 10 = Major tectonic units; 11 = Horst; 12 = Graben

(3) Observations preceding our investigations (Urbancsek, Rónai) had already indicated that as a rule the water-table lies deeper in the coarser sediments than in the finer ones of the same area. A thorough analysis and plotting many thousand data on map proved this phenomenon to show a regular change from geotype to geotype. Namely, the coarser sediments overlying buried accidents (blocks, ridges, etc.) usually exhibit lower pressures and yield waters of lower temperature than do the finer-grained sediments of the same place. On the other hand, in the deep basement subsidences, as a rule, it is the coarser sediments that yield waters of higher pressure and higher temperature.

(4) In terms of Bernoulli's law, migration with greater speed possible in the coarser sediments is associated with lower hydrostatic pressure. In addi-

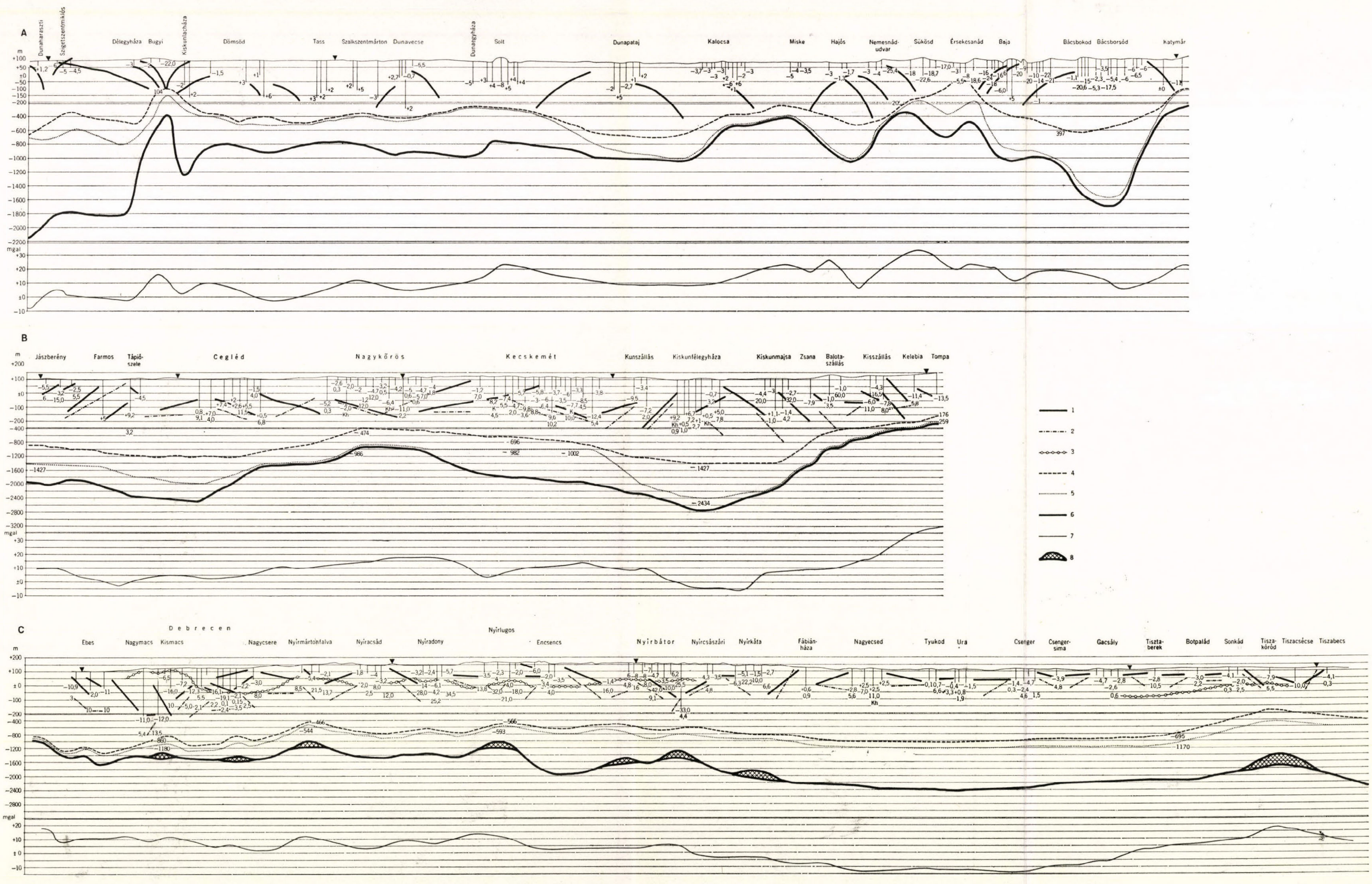


FIG. 4. Relationship between pressure conditions of artesian waters and deep structure (L. Simon)

1 = Trends of pressure variation; 2 = Trends of variation of the depression necessary for obtaining a water yield of 20 l/min through a filter with a length of 1 m; 3 = Bottom of the Pleistocene; 4 = Bottom of the Upper Pannonian (by courtesy of Gy. Kertai—L. Kőrössy); 5 = Substrate of the Pannonian basin (by courtesy of Gy. Kertai—L. Kőrössy); 6 = Basement (by courtesy of L. Kőrössy); 7 = Profile of the gravitation anomalies (by courtesy of V. Scheffer); 8 = Eruptive rock

tion, we may presume that in the case of deep basins, the expansion of the broad space of migration diminishes the speed of migration to such a degree that the water practically stagnates in the finer sediments there. Bernoulli's law, however, still cannot be applied for interpretation of the phenomena discussed in paragraph 3.

Nevertheless, it is suitable for interpreting an additional phenomenon. In fact, if we accept the validity of Bernoulli's law, we have to assume that above the elevated blocks where, according to this law, migration has a greater speed, a more pronounced differentiation of various sediments must have taken place during geological periods. This seems to be confirmed by the fact that after each 6 months winter pause, the irrigation tube-wells have to be subjected to a lengthy process of purification by pumping, because the streaming waters silt up the aquifer around the well even within such a short span of time. The analysis of the set of data of 2,150 wells proved our assumption to hold true in about 80% of the cases. Accordingly, in the areas of deep-seated basins the aquifers are characterized chiefly by a lack of differentiation in the sediments, while the areas of basement horsts are characterized by their differentiated pattern. In the Danube—Tisza Midregion the relationship can be demonstrated pronouncedly according to tectonic geotypes. In the Nyírség, however, comparatively more undifferentiated sediments reflect the main features of palaeohydrography, i.e. the buried valleys and channels of Pleistocene palaeostreams. This is confirmed by the data furnished by other methods of palaeohydrographic surveying.

The two phenomena discussed in paragraphs 3 and 4 also refer to each other. Where the speed of migration increases according to Bernoulli's law, we can find differentiated sediments and, at the same time, positive anomalies of the geothermic gradient (i.e. waters of higher temperature are obtainable from the same depth). In areas of large subsidences it is the finer sediments that yield waters of lower pressure and temperature. This is presumably due to the fact that here the water in the finer sediments is stagnant or shows practically no movement. At the same time, we have to point out that the difference in temperatures recorded from the coarser and the finer sediments does not provide, in itself, any satisfactory explanation for the differences in pressure. In fact, the temperature differences are as little as 2 to 5 °C, which would justify water level differences of a few decimeters only, whereas the real water level differences are of the order of meters. Consequently, the problem of intepreting the different water levels observed in sediments of different grain size is still far from being settled. At the same time, we would like to stress that our research may reveal some pieces of evidence for a better interpretation of the geothermic gradient. According to our measurements the heat accumulated as a result of the friction between the streaming water and the water-bearing strata, in geological spans of time, must also have had some part in the shaping of the geothermic gradient (Figs 5a-b, 6).

(5) The migration trends can be well traced, especially for the area of the Nyírség. The maps of geothermic gradient were made by using the data on bore-holes, spaced much more densely than was in the case with any former (Sümeghy, Schmidt) survey. Since the specific yield (litre/min/1 m de-

pression) also appears to be interrelated with migration, detailed maps showing specific yield have also been plotted. When preparing the geothermic gradient maps, the specific yield was computed for the actual filter length of the wells, which resulted in a considerable range of error. To avoid this, we computed the specific yield for approximately 1 m filter length and 160 mm tube diameter. In addition, the values of the geothermic gradient

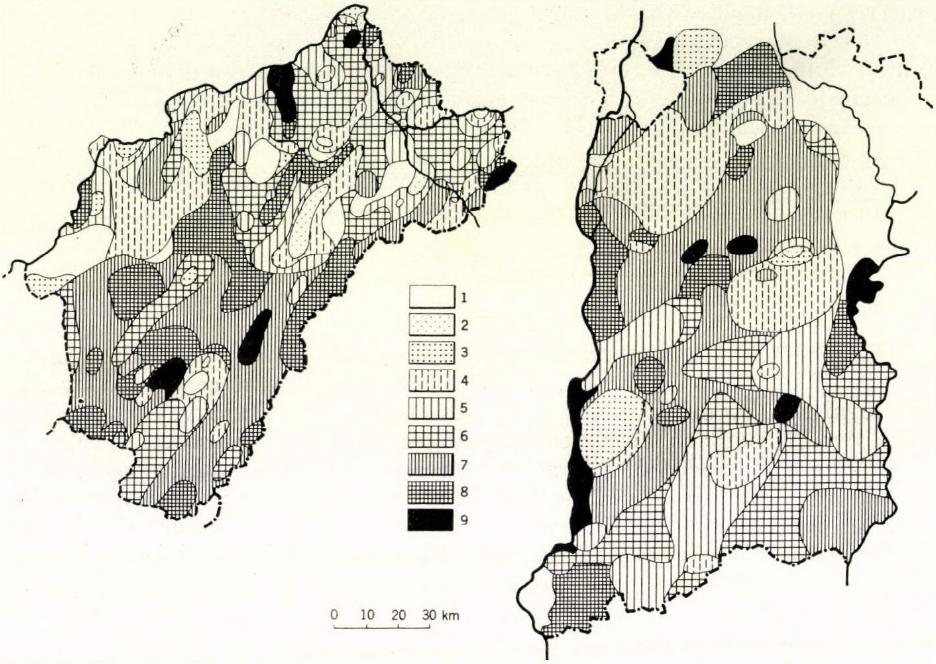


FIG. 5a, b. The geothermic gradient in meter (L. Simon)

1 = above 60; 2 = 60 to 50; 3 = 50 to 40; 4 = 40 to 30; 5 = 30 to 25; 6 = 25 to 20; 7 = 20 to 15; 8 = 15 to 10; 9 = below 10

were plotted in the form of columnar diagrams in such a way that the columns express, in degrees of centigrade, the increase of temperature at 200 m depth. The maps of specific yield and those of geothermic gradient also show a marked correspondence (Figs 7, 8). This seems to confirm the supposition that the changes in values given in these maps are due to a common cause. And this common cause must be found in the changing intensity of migration from area to area.

(6) The regular relationships outlined permit interpretation of the pressure conditions of the artesian waters. So we can interpret the characteristic pressures, whether negative or positive, of the various geotypes as well as the increase of pressure in relation to depth. The latter is expressed simply by the coefficient resulting from the resistivity and friction of the strata.

However, no satisfactory interpretation is provided by any known relationships for the phenomenon observable in areas of negative pressure: that is, for the decrease of pressure with increasing depth. To explain this phenomenon, two water systems are presupposed: (a) the uniform water system of the whole Great Plain basin (abyssal or major system), the pressure of which

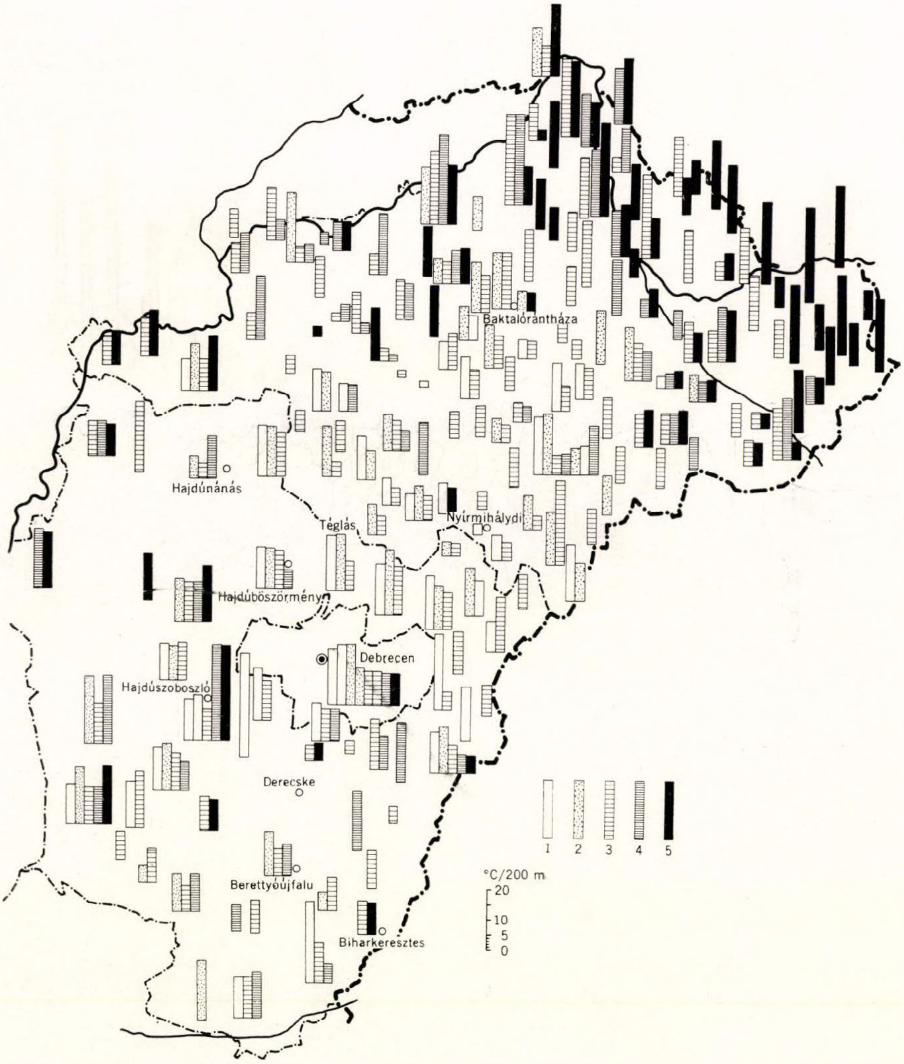


FIG. 6. Regional changes of the geothermic gradient of the near-surface (30 to 300 m) strata (L. Simon)

1 = in silts; 2 = in fine-grained sands; 3 = in medium- grained sands; 4 = in coarse-grained sands; 5 = in gravels and sandy gravels

increases in proportion to depth even in areas of negative pressure; its recharge proceeds from the direction of the basin edges; (b) a local water system fed by local precipitation and surface waters, chiefly rivers; its

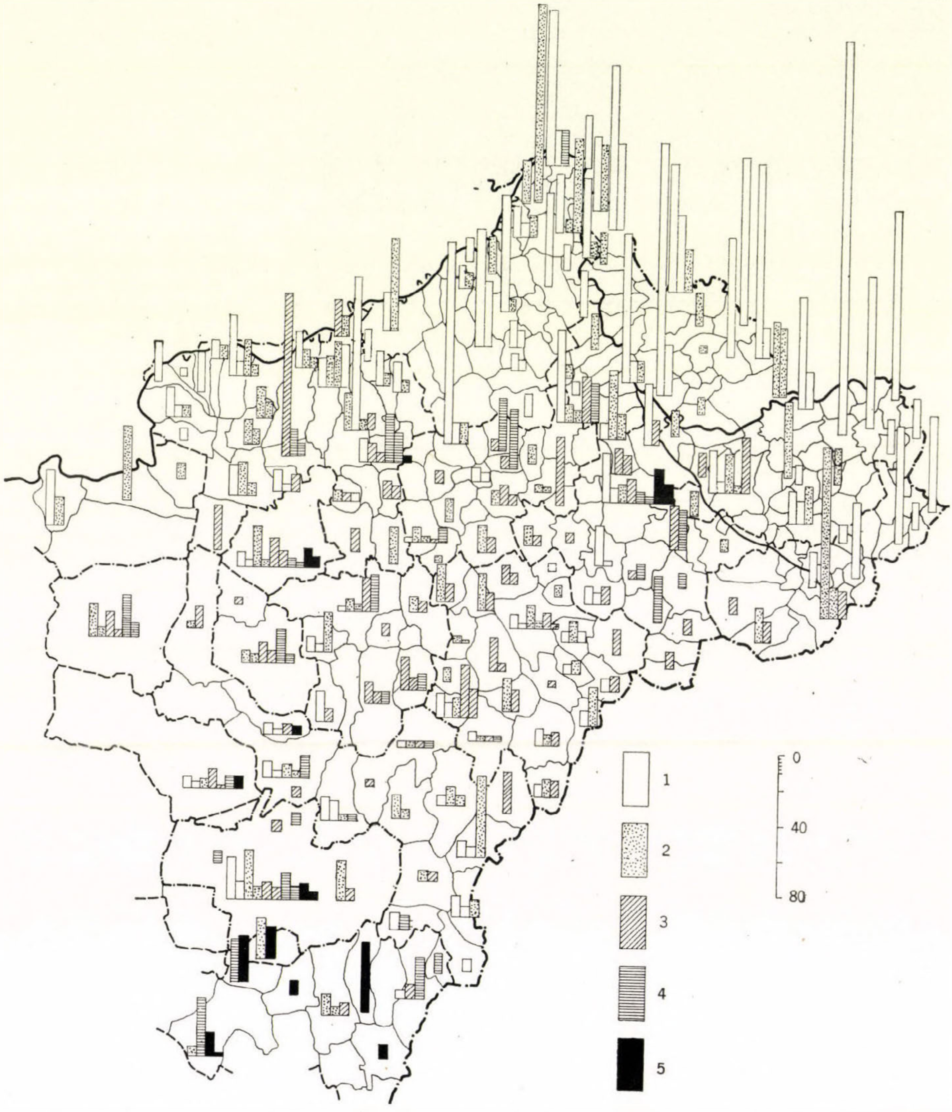


FIG. 7. Specific yield of wells (in l/min as computed for a filter with a length of 1 m, a diameter of 160 mm and a depression of 1 m)

1 = from depths of 0 to 50 m; 2 = 50 to 80 m; 3 = 80 to 110 m; 4 = 110 to 150 m; 5 = 150 to 200 m

pressure decreases with depth. These two systems balance each other hydrostatically. They are actually present in the areas of positive pressure, too, but the depth range of the local system is limited there, and the effect of

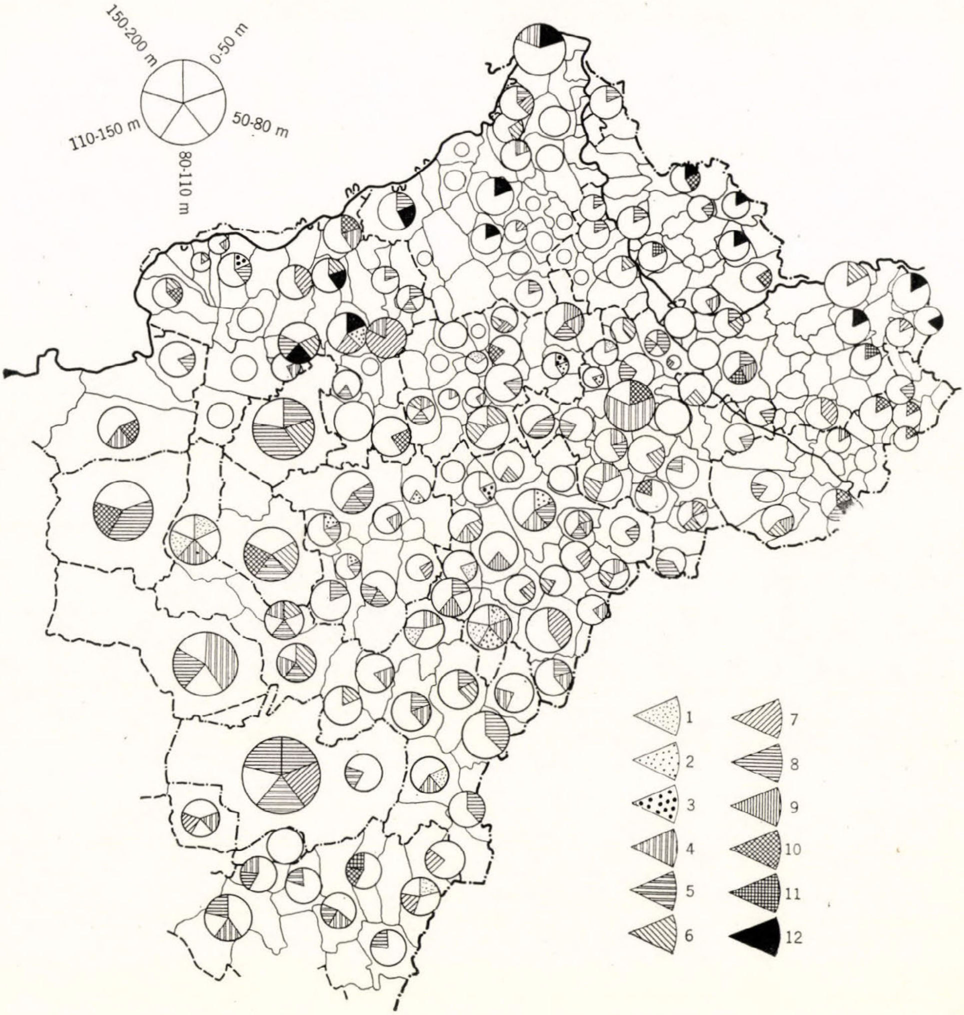


FIG. 8. Water yields obtainable by a centrifugal pump located without sinking (in l/min

1 = 0 to 50 l; 2 = 50 to 80 l; 3 = 80 to 100 l; 4 = 100 to 150 l; 5 = 150 to 200 l; 6 = 200 to 300 l; 7 = 300 to 400 l; 8 = 400 to 800 l; 9 = 800 to 1,200 l; 10 = 1,200 to 1,600 l; 11 = 1,600 to 2,000 l; 12 = above 2,000 l

the abyssal or major system may reach up to the surface. This is also indicated by the fact that in such areas the groundwater-table, itself, lies very high and often causes inland water damage in spring-time.

The pressure of artesian waters, developed by the complexity of endogenous factors, is compensated for by the complexity of atmospheric pressure, evaporation and local infiltration, depending on surface relief, too. The losses of migrating waters are also due, for the most part, to evaporation and partly to seepage towards the river.

(7) By taking into account these general, regular, hydrogeological relationships, we continued in our practical studies to examine in detail the geological development of the region. We could safely rely upon valuable evidence published in literature, particularly in the essays by Sümeghy, Kőrössy, Scheffer, Erdélyi and Ozoray, and in Borsy's physiographical monograph of the Nyírség. The major part of the region is characterized by subsided Miocene volcanites buried by the sediments of the Pliocene (Pannonian) sea (e.g. at Nyíregyháza the borer found volcanites within the interval of 1,150 to 2,550 m). Therefore oil-prospecting drillings are carried out comparatively seldom in this area. That is why its deep structure and stratigraphy are known to a lesser degree than those of the other Great Plain areas, which are more promising for the presence of hydrocarbon deposits (oil and gas). On the basis of the above-discussed regular relationships between the pressure conditions of artesian waters and deep geological structure, however, we were able to complete the data on the deep structure which was obtained by drilling as well as by geomagnetic, geoseismic and gravimetric measurements.

(a) By comparing these data, the following major tectonic features can be established for the Nyírség. In the Mesozoic era the Palaeozoic basement subsided and formed two deep basins; one of them has its centre south of Nyíregyháza. This basin, particularly its central sector, had been filled with the products (1,000 to 2,000 m thick) of the Miocene volcanism. The other basin has its centre in the area of the present Ecsed Swamp Area which includes only a small proportion of igneous rocks, its filling consisting chiefly of Pliocene marine sediments.

(b) In the Pliocene, the Pannonian transgression first filled only the surface depressions, the partial basins, but the Upper Pannonian sea completely inundated the area, so that its sediments are intersected by the deeper boreholes almost everywhere. Its top horizon shows fluviatile facies. On the Pannonian horsts not affected by the Late Pannonian erosion, a lasting terrestrial weathering produced red clays and occasionally red sands. These reliable index horizons of the Pleistocene substrate lie at different heights (+90 to —50 m as related to the present sea level), indicating the sizes of the Upper Pannonian and Pleistocene dislocations.

At the turn of the Pannonian and the Pleistocene, the main dip of the region was meridional. However, as a result of the subsidence of the northern part of the Hajdúhát, adjacent W of the Nyírség, the rivers running from the direction of the Carpathians crossed the Nyírség in NE-SW direction in the first half of the Pleistocene. Meanwhile they made incisions and gradually accreted the slowly sinking area with their gravels and sands. According to our results, the Tisza during the first half of the Pleistocene flowed across the SE part of the present Nyírség, crossed the area of Mátészalka and Debrecen and ran towards the centre of the Great Plain. The wells of high capacity of the Debrecen Waterworks tap the Early Pleistocene gravels and coarse sands of the rivers Tisza and Szamos, at depths of 120 to 180 m below the present surface. The wells of the Nyíregyháza Waterworks near Kótaj also draw water from the Early Pleistocene river deposits. At present, the wells of these two waterworks have the highest yield in the Nyírség. They are characterized by their having been sited on the edges of Pannonian horsts and sunk into the deposits of Early Pleistocene rivers that had made comparatively deeper incisions, due partly to tectonic reasons, partly to erosion.

These river beds, incised into the Pannonian terrain and filled, as a rule, by coarse sediments and gravels, can be traced at a number of points in the region. Hydrogeologically, the Pleistocene deposits occurring at the fringes of the elevated Nyírség are the most favourable within this type. Debrecen and Kótaj have such a favourable position. The excellent hydrogeological conditions due to the marginal position are regular throughout the Great Plain, including the Danube—Tisza Midregion. The particular economic significance of this regularity consists in the fact that the structural borders are at a distance of 15 to 30 km from the marginal rivers, so favourable conditions for water production exist, whereas the water of the rivers could be diverted only by means of expensive canals. These aquifers may be tapped by wells with a capacity of 1,000 to 2,000 l/min and with a specific yield of 80 to 200 l/min/m. The hydrostatic level, in turn, proves to be very uneven, its position varies between +2 and —25 m, depending on the abyssal structure. However, high yields can be obtained, but only at depressions of 10 to 30 m, i.e. by means of plunger or mammoth pumps.

(c) About the middle of the Pleistocene, perhaps in the Thyrrenean Rissian the NE embayment of the Great Plain which was formerly elevated was also subjected to intensive sinking; in the mountain region the rivers obtained greater energy, were incised and began to deposit their abundant coarse detritus which gave rise to a continuous alluvial fan in the N-NE part of the Nyírség. The main direction of flow then became meridional; the Carpathian rivers ran southwards, parallel one to another, towards the Tisza (the present-day Ér and Berettyó line) which had shifted farther to the south. The formation of the alluvial fan and the filling of the southern continuation of the basin with gravelly, sandy, silty and clayey sediments, becoming finer upwards and southwards, lasted till the end of the Pleistocene. The thickness of the Pleistocene sediment sequence varies between 30 and 250 m, depending on the Pannonian topography as well as on the size of the Pleistocene subsidence. This huge sequence and especially the palaeostream channels and their coarse-grained riverine alluvia, and possibly the quicksand formations, too, include the major aquifers of the region, which have been fairly utilized already.

The intensity of subsidence was not uniform. Particularly important is the observation according to which the Szatmár-Bereg Plain, especially its southern part, sank more intensively than the Nyírség Platform did. On this plain, the deep borings intersected Pleistocene gravels 160 to 180 m thick, but the gravels were found to range under the Nyírség (from the E) only at depths of 80 to 100 m. In the northern part of the Nyírség, the gravel horizons begin at depths of 10 to 15 m under the surface. Thus the Szatmár-Bereg

Plain had a preliminary function of sediment-selecting during the Pleistocene. Its unfavourable hydrogeological influence on the Nyírség is undeniable.

In the sedimentary sequence some rhythm can be realized. The three fluviatile series, recorded earlier by Sümeghy, are well reflected almost everywhere in the 25 geological sections lying throughout the region in various directions. They are separated one from another by intercalated clay horizons, i.e. clay lenses arranged in the same horizons roughly in a chess-board pattern. In some of our deeper sections 5 to 6 such clay horizons run in a continuous line. The alternation of these horizons can be correlated with the terraces occurring in the surrounding mountains. They correspond to the alternation of the stadials and interstadials. Their hydrogeological importance consists in that the clay horizons separate quite different, though intercommunicating, aquifers. The water-yielding capacity of the aquifers is different, even if these are composed of sediments of identical grain size, and it usually—but not always—increases with depth.

Owing to Pleistocene movements, or rather to erosion and accumulation, a number of strata show fracturing, wedging out, thinning and lenticular shape. The Pleistocene series, as a rule, is extremely varied even within a small area. All these factors are responsible for the fact that in the uppermost Pleistocene sequence the water-bearing function of the palaeostream channels is less conspicuous than it is in the lower-seated, coarser strata. In this sequence the alluvial layers are often better aquifers than the former river beds which were disturbed by tectonic movements or erosion. Nevertheless, the buried beds often yield abundant water. Consequently, the tracing of buried beds and the detailed exploration of palaeohydrography by layers have more than merely theoretical importance.

(d) As regards Holocene history, sedimentation has hardly any importance for water production. Of the Holocene formations, it is only the gravel layers occurring on the NE, chiefly in the Szatmár-Bereg Plain, that may count as aquifers. The negative role of the Holocene formations, notably the blown-sand masses forming local accumulations 20 to 30 m thick, is more significant. They require deep water-prospecting borings. The groundwater-table — the uppermost level of the subsurface waters — also lies within the Holocene formations. Its flattened waves follow the pattern of the surface relief, but they are situated under the surface at depths of 1 to 12 m, depending on the abyssal structure.

The Holocene tectonic movements play a more considerable role than the sediments do. The present marginal troughs of the Nyírség: the Bodrogköz and the Rétköz (on the N) and the Szatmár-Bereg Plain (on the E) subsided in the Holocene. At the same time the Nyírség Platform was uplifted, not evenly, but in a circumflex pattern. Its ridge coincides with the present main surface watershed running roughly in the line of Hajdúhadház—Mátészalka. The highest points of the watershed exceed the height of 180 m a. s. l., while the average height of the entire landscape is 120 to 130 m. The adjacent marginal troughs lie, on the average, 20 m deeper. On the margins the Holocene tectonic movements broke the beds of the Pleistocene rivers. This is particularly conspicuous on the SE. So the former surface streams of the Nyírség were liquidated. Today, the rivers are only tangential to its edges.

Owing to these conditions, the zones of water recharge, running from the direction of the surrounding mountains, are broken, while on the edges the water swells, so that its local abundance increases.

Some technological and economic problems

(1) Water yields are characterized by extremely varying conditions, which may be only roughly indicated by the hydrogeological units mentioned above. Urbancsek's average maps provide excellent basic information, nevertheless the maps of water-yield peaks and optimum specific yields are also indispensable. Where wells with a yield of 100 l/min can be operated by centrifugal pumps, the irrigation of apples seems to be feasible. To irrigate vegetables is remunerative only from wells with the low yield of 200 to 250 l/min, while the irrigation of green fodder crops only pays if done from wells with yields higher than 400 l/min and depths not exceeding 50 to 60 m.

The water yields bring up, again, the problem of recharge. As to the recharge of artesian waters, Balló's standpoint is completely negative. He suggests that there is no recharge from external areas. Major has advanced similar views. Ubell considers that along the fracture lines the groundwater recharge is possible from external drainage areas, too. He says, as regards artesian waters: "Where classical artesian conditions are prevailing, no water migration is likely to take place in the deeper strata, until they are exposed by boring". He holds that precipitations are the source of groundwater recharge, which is in equilibrium with the withdrawal (resulting from evaporation and natural run-off). Hence, the recharge is essentially an exceptional phenomenon. E. Róbert Schmidt and Juhász suggest a compromise, according to which there is no recharge below 300 to 400 m, but only above that level. Juhász thinks the amount of recharge not to be greater than 2 to 3 km^3, i.e. 20 to 30 mm per year in the centre of the Great Plain. According to Szebényi, the recent strata of the Great Plain dip towards the centre of the basin, so there are possibilities of recharge from the edges, as well as for the development of the hydrostatic pressure necessary for a recharge by ascending migration. Rónai also emphasizes the recharge from the edges, but makes an exception for the groundwaters of the Nyírség Watershed. The concept of recharge from the edges is advocated by Urbancsek, who suggests that the depression does considerably increase this possibility.

In our opinion, the recharge from the edges proceeds along the previously discussed main lines of palaeohydrography. Its deep flux is moving in a horizon deeper than the beds of the Tisza and the Szamos, the lower limit being represented by the Pannonian surface. Within the Nyírség Watershed an ascending migration may also be presumed, which may provide some recharge — diminished by evaporation — for the groundwaters, too. This suggestion is confirmed by the fact that the elevation of the groundwater table and the hydrostatic level of artesian waters are the same or have the same proportion within one area. Recharge is controlled by withdrawal, i.e. by evaporation under natural conditions and by depression in the case of well operation.

The quantitative data on recharge are still unknown. But, if we assume merely the 20 to 30 mm per year indicated by Juhász, this still would provide a water cover of 200 mm for $15^0/_0$ of the area (and that is all the terrain in the plan for irrigation). A second viewpoint — as suggested by Major — lies in the peculiar granulometric composition of the rocks in the Nyírség, which allows a water migration of 0.4 $l/sec/km^2$. And this makes 16.5 mm per year, i.e. a water cover of 165 mm for $10^0/_0$ of the area.

(2) The technology of wells raises a very important problem. Proper well-logging and precise determination of the aquifers — occasionally even by using the costly method of electrical well-logging — are of fundamental importance. In fact, inaccuracies of 4 to 5 m are not infrequent with the so-called "straight-flush well boring", which may reduce the yield to one-fifth or one-quarter. The introduction of a more precise well-logging, around 1950, increased the capacity of the wells by nearly five times in five years on the average. By using a proper well technique, a decisive improvement can be made, and higher water yields than those currently known could be obtained. An up-to-date well technology will permit yields, similar to those in Debrecen and Kótaj, at many places in the Nyírség. And a yield of 200 to 400 l/min can be obtained at many points of the river valleys, even by using centrifugal pumps (Fig. 2).

Pump-engineering should be materially improved. Although pumps of high delivery head (50 mm), with capacities of 100, 200, 400 and 800 l/min are available, the water yields do not always correspond to the optimum capacity of the pumps. Therefore: in case of low hydrostatic level and low specific yield, pumping systems (possibly multi-stage ones) located in shafts ought to be used; for an optimum water yield groups of wells should be developed.

In our cost computations the well groups — which involve most surplus costs — have already been taken into account. In exceptional cases the use of plunger pumps can do as well. The withdrawal of water is effected by plunger pumps at Nyírlugos.

(3) So the main cost factors depend on water yield and technology. We have assumed an operation of about 1,200 hours per year, which for a period of 3 to 5 months allow 12 hours per day for irrigation and 6 hours per day for preparations (rearrangement of the pipe-lines). Working of a nightshift is justified technologically by the lower evaporation loss. Under such conditions a well of 100 l/min capacity can supply a water cover 200 mm thick for about 7 hectares of land. For apple, this is satisfactory. The amortization time is scheduled to be 10 years for well-boring and 5 years for equipment. The costs estimated for irrigation of 1 cadastral yoke by a basic unit, i.e. by a well 50 m deep with 100 l/min capacity equipped with a half-stable subsurface tubing are as follows (total annual operation costs and amortization):

well (90,000 Fts)	750	Fts
engine	500	,,
pump	150	,,
nozzle	400	,,
tubing	700	,,
operation costs (fuel, wages, preparations)	2000	,,
additional expenses for agrotechnics (fertilizers, etc.)	500	,,
Total:	5000	Fts

On the other hand, 30 q increase in apple production equals 9,000 to 15,000 Fts wholesale price.

The bigger the water yield of a well or well group, the cheaper is the irrigation per areal unit, as the specific costs are distributed on a proportionately larger area. So the annual irrigation costs per 1 cadastral yoke, if 30 ha are irrigable from 2 well groups 4 wells each with 100 l/min capacity, will be as low as 3,900 Fts. For a single well of 200 l/min capacity (from a depth of 50 m), the cost is 3,700 Fts, and for a well-group with wells having a total capacity of 400 l/min the cost is 2,300 Fts.

Considering these basic cost factors, we have prepared a parish-scale map of irrigation costs for a water cover of 100 mm. The computations have been performed, naturally, for proper depths, occasionally for 120 to 150 m.

(4) Large-scale farming creates prevailing special requirements as to the choice of irrigation technology. The water yield of 400 l/min, mentioned several times as the lower limit of rentability, has been considered as the lowest limit for large-scale utilization. It should be noted that the 400 l minimum is, first of all, the lower limit of the rentability of irrigation in general. A single (50 m deep) well with a capacity of 400 l/min can provide, at a cost of 2,900 Fts, a 200-mm thick water cover for 15—18 hectares, which makes the raising of the animal products economical. But as modern, large-scale fodder production is economical on plots of several hundred cadastral yokes, the irrigation system could be made suitable for large-scale production only by a purposeful areal arrangement of the well-network, even if wells of such high capacity were used. A single well cannot adequately supply a large-scale plot, for even the exceptional 1,200 l/min wells are able to feed 60 to 70 ha only.

In conclusion, from the point of view of commercial agriculture, the irrigation of apple orchards by means of wells of 100 l/min capacity, as a lower limit, is not more problematic than the general cropland irrigation by wells of 400 l/min capacity adopted as a lower limit.

Considering the above, we hold that the irrigation of 36,000 hectares of land with an annual water cover of 100 mm is feasible within the physiographic landscape unit of the Nyírség. This also includes the area which is outlined in the papers of Ozoray and Major. For the sake of simplification, further discussion will consider the whole irrigable area from the point of view of apple production, observing, at the same time, that in the Rétköz and the northern Nyírség several thousand hectares of land are suitable for remunerative irrigation of other cultures, especially cropland fodders and potatoes.

(5) The investment required is 600 million Forints, i.e. slightly more than the surplus value, which the Nyírség "swingers" (i.e. country-dwellers working in Budapest and returning home every fortnight) annually contribute, at the cost of their own sacrifices, to the increase of national income. According to the plans for plantations, this capital ought to be invested in the coming 20 years. So the supplementary investment input required in agricultre would be 30 million Fts per year, i.e. round 10% of the expenses for the planting of apple orchards.

In contrast, the surplus yield expected for 36,000 ha of apple orchard is 180,000 tons, which brings 700 million Fts at current wholesale prices. Consequently, the total capital invested will be completely amortized by the value of the surplus products of one year plus the net value of the production of two years. Such rapid amortization is quite exceptional in industry.

Geotypes

The geotypes (Fig. 9) are, on the one hand, tectonic ones (i—x), which represent, in part, the drainage basins of the individual major Pleistocene rivers. The boundaries of these areas are tectonic lines which, however, have been shown on our map not by fracture lines, but in a generalized way, following the stratigraphic, water yield and morphological data. On the other hand, the geotypes are brought to relief by generalizing the quantitative and depth characteristics of water production (1—10). These types are rather hydrogeological ones and more precisely are interconnected with the tracks of palaeostreams, indicating the main trends of recharge, too.

The geotypes are essentially in congruence with the geomorphological, pedological production structural maps — which cannot be discussed here in detail — and (owing to the transitions between the geotypes of production) even with the maps of population density, especially with those representing the relationship between agricultural labour migration and intensity of agriculture.

(A) The chief characteristics of the tectonic types are as follows:*

(i) The Holocene subsidence area of the Szatmár-Bereg Plain was formed during the Pleistocene, when the rivers, on their way towards the Nyírség, filled the basin, which was sinking at that time too, with thick sequences of gravels and coarse-grained sands. These thick sequences are abundant aquifers. The black spots on our map represent areas suitable for tube-well irrigation of every crop type in about 60,000 hectares of growing area. Area (ia) was an intensively sinking small basin in the second half of the Pleistocene; its gravel sequence extends from a depth of 150 to 170 m almost up to the surface, while in the zone stretching south of it the gravels begin only at 20 to 30 m (ib). The gravels of the southern part of the plain (ic) penetrate, near the surface, into the area of the Nyírség, too.

(ii) The Holocene depression of the Rétköz exhibits less favourable hydrogeological properties than the former one does, but, along the tectonic line of its southern edge, the pressure conditions of the waters stored in the coarse-grained sediments, which have been accumulating from the Early Pleistocene on (Nyírbogdány—Kótaj), are favourable, owing to tectonic disturbances. This holds true especially of the deeper strata.

(iii) A Pleistocene depression of moderate size—or erosion valley—is the area which was the drainage basin of the Palaeo-Ung—Laborc in the Early Pleistocene. Later, the western part of the depression became the

* Legend to Fig. 9.

drainage basin of the Palaeo-Bodrog. A relatively higher water yield is expected from the strata lying deeper than 50 m.

(iv) The ancient drainage basin of the Palaeo-Latorca (Latorca—Borzsa?) is a moderate depression similar to the former one. The relatively higher specific yield of the deeper-seated (50 to 150 m) strata at Nagykálló, Újfehértó and Érpatak is the result of marginal swelling.

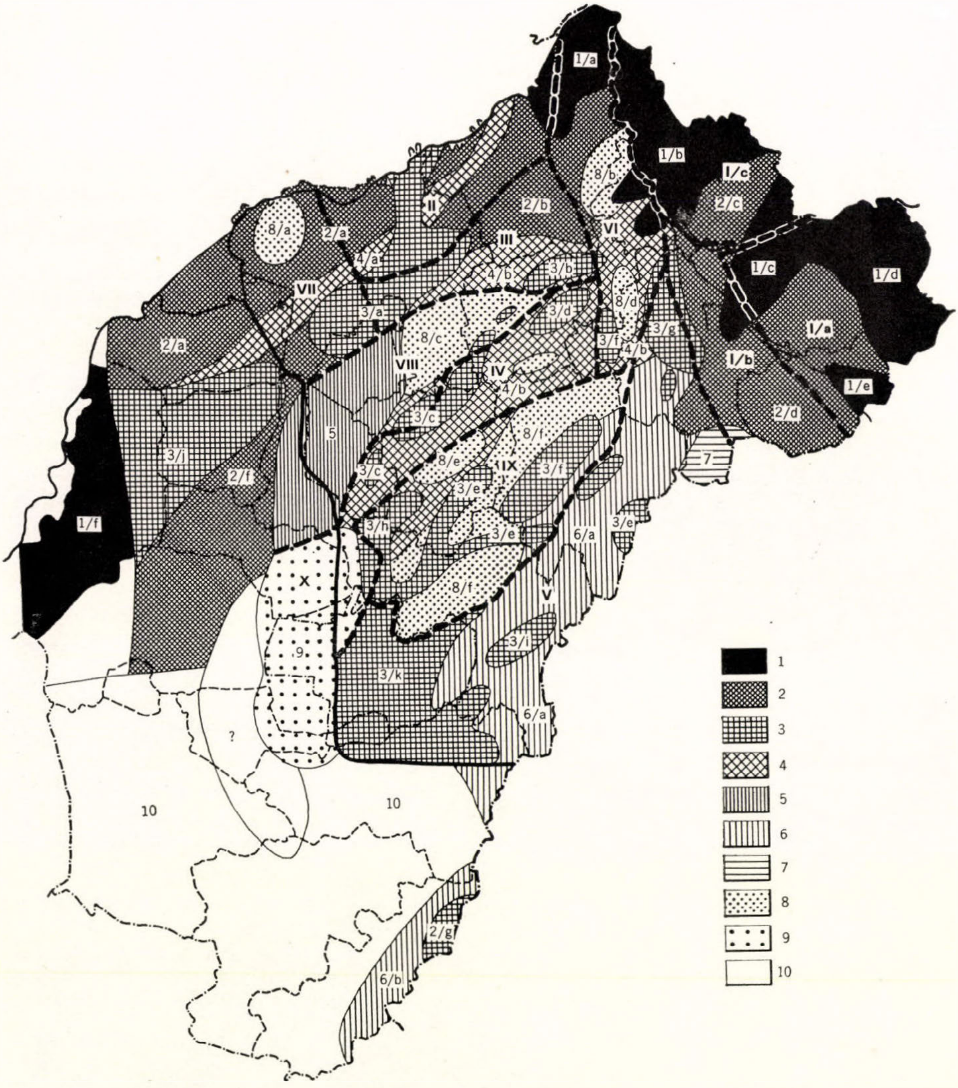


FIG. 9. Geotypes of artesian water production (see legend in the text)

(v) The depression of the Palaeo-Tisza—Szamos dates from the beginning of the Pleistocene, when the river shifted gradually to the south. The exceptionally favourable hydrogeological conditions of Debrecen are due to marginal swelling. The recharge of the Early Pleistocene water-bearing series of Debrecen is still problematic. The apparent drop of the water level in the wells of the Waterworks are undoubtedly the result of withdrawal, at least in part. This means that the recharge is smaller than current consumption (the latter corresponds to an annual water cover of 50 mm for an area of 120 km^2). The two possible main directions of recharge are also indicated by the map (our cross-section shows them clearly). Of these, however, it is probably only the northern one that delivers water to the Debrecen Basin, while the southeastern zone, i.e. the zone of the former Tisza, conveys its water towards the water-bearing series of Vértes, Nagyléta and Derecske, lying deeper than the Debrecen aquifers.

(vi) The structural basement of the north-eastern Nyírség is a high-seated Pannonian block; at Záhony there are no gravelly sediments at depths exceeding 85 m, and this certainly holds true of the other points of the block, too. On the N its surface was overlain by a cover of Pleistocene fluviatile gravels 20 to 30 m thick. This is an excellent aquifer. At the latitude of Gyüre—Vásárosnamény the Pannonian block was incised by the Palaeo-Latorca—Borzsa; otherwise, it represented a watershed between the Latorca and the Ung. Its gravel-free portion immediately north and south of the Latorca Valley is inadequately aquiferous.

(vii) The north-western Nyírség is a Pannonian block similar to the former one, probably connected with that of Nyíregyháza. Its southern part, however, was cut across in a wide belt by the Ung—Laborc in the Early Pleistocene, and later the Palaeo-Bodrog eroded it in the direction of Rakamaz—Kótaj. The hydrogeological properties of its northern part are unfavourable.

(viii) The Pannonian block of Nyíregyháza is probably a direct continuation of that of Hajdúböszörmény, but it subsided slightly in the Pleistocene (Riss?). From that time onwards its western part received further rivers from several directions, while its eastern part was deeply incised by the Palaeo-Latorca. The former river valleys are likely to represent deep incisions. These are relatively more abundant aquifers, though with poor or medium specific yields.

(ix) The Pannonian block of the Nyírség Watershed may have uplifted and subsided several times in the Pleistocene. In the Early Pleistocene it had a high position, like at present; its present day position dates from Late Pleistocene — Early Holocene. It used to act as a watershed between the Palaeo-Latorca and the Palaeo-Tisza, but was cut across several times, owing to its mobility. The locally high values of iron content (3 to 4 p. p. m.) result from the stagnation of water rather than from the weathering of iron-bearing sediments. The rock suits of the incised valleys are locally (Szakoly, Nyírbogát) so abundant in water that they are regarded as good aquifers under the conditions of the Nyírség, yet the sections between the former valleys, which represent, on the whole, the greater part of the area, are made up of clays and fine blown-sands.

(x) The Pannonian block of Hajdúböszörmény and Hajdúhadház lies, for the greater part, outside the Nyírség Region. It is the most stable part of the whole area. The good aquifers of Hajdúböszörmény have been formed by incisions.

(B) The depth- and quantitative-types have already been interpreted under the tectonic types. The latter, however, by no means coincide with those which indicate practically the water production. This is due to the fact that depth and water content characteristics are, in the last resort, the results of erosion and accumulation processes. The second category group distinguishes, in fact, such erosion-accumulation types. We do not deal here with the characterization of the individual types, but rather restrict ourselves to general considerations concerning the interpretation of the legend of our map:

(a) The colour-scale expresses, as a rule, the increase in the values of water yield and specific water yield (the lighter colour, the lower water yield). This fundamentally depends on the ratio of the coarse fraction. However, as we have seen, it is dependent on other factors, too, such as recharge, blocks provoking swelling, and possibly the position of big masses of impermeable sediments.

(b) The legend provides information on depth conditions, too. So the difference between type 2 and 3 consists essentially in the fact that the aquifers of type 3 lie at greater depths and originate either from Early Pleistocene rivers or more recent ones which, however, have incised their beds more deeply. Type 5 is tectonically identical with type 8c, but the former has been dissected in many directions and deeply by rivers, so that it represents a more favourable hydrogeological formation. Types 3 and 6 are usually made up of river deposits, and their aquifers do not only lie at greater depths, but also have a low yield in general.

*Bibliography**

Balló, I. (1961) Az ártézi jelenségek (Artesian phenomena), *VK*, vol. XLIII, no. 4

Fekete, I. (1962) A csőkutas öntözés Bács megyei tapasztalatai (Experience of tube-well irrigation in Bács county), Mezőgazd. Kiadó, Budapest

Kőrössy, L. (1963) Magyarország medenceterületeinek összehasonlító földtani szerkezete (Comparison between the geological structure of the basin regions of Hungary), *FtK*, vol. XCIII, 153—72

Ozoray, Gy. (1964) A Nyírség vízföldtana (Hydrogeology of the Nyírség), *FÉ*, no. 1

Rónai, A. (1963) Az Alföld negyedkori rétegeinek vízföldtani vizsgálata (Hydrogeological research into the Quaternary beds of the Great Plain), *HK*, vol. 43, no. 5

Simon, L. (1964) Néhány vízföldtani törvényszerűségről (On some hydrogeological laws), *FÉ*, no. 2

Urbancsek, J. (1963a) A földtani felépítés és a rétegvíznyomás közötti összefüggés az Alföldön (Relationship between geological structure and pressure of artesian waters), *HK*, vol. 43, no. 3

Urbancsek, J. (1963b) Pliocén és pleisztocén üledékek földtani szintezésének újabb lehetőségei a vízföldtani kutatásban (New possibilities for geological division of Pliocene and Pleistocene sediments in the geological research), *HK*, vol. 43, no. 5

* A detailed list of references to this problem is given in *FÉ*, 1963, no. 3, 337—9.

INTERNAL MIGRATION AND DECREASE OF AGRICULTURAL POPULATION IN HUNGARY

by BÉLA SÁRFALVI

The geographical distribution and the settlement of the population — the most important and, at the same time, most mobile component of the force of production — are determined by the distribution of the material forces of production, some of which (cropland) are geographically *a priori* fixed, while the geographical distribution of others is partially influenced by various location factors, i.e. they are also stationary to some extent. Any change in the areal system of the productive forces will provoke a geographical regrouping of the population.

In countries with advanced economy the process which is most fundamental and characteristic of the socio-economic restratification of the population — the decrease of agricultural population and its influx into industry and other non-agricultural occupations — has been going on for more than a century. In some highly developed countries, such as Great Britain, Belgium and the USA, this process has virtually ended, since the proportion of the agricultural population in the total working force has dropped to 4%, 10% and 11%, respectively. In Hungary, because of her slower economic development and peculiar historical conditions, large-scale migration from the countryside started much later, and its pace had been impeded for a long time.

In 19th century Hungary, the cropland still played a predominant role among the forces of production, owing to a relatively underdeveloped social and areal division of labour. At that time the density of population was controlled more or less consistently by the random productivity of soils that could be attained at the given level of socio-economic development. Changes in utilization and productivity of soils — as a consequence of technical development, of course — prompted some migratory movement in the agricultural population. For example, the changes in the areal distribution of the population between 1869 and 1900, irrespective of Budapest, were closely connected with the putting under cultivation of sandy soils in the Danube—Tisza Midregion: the areas scarcely populated then caused a considerable internal migration.

At the beginning of the 20th century the growing industrial productive forces first affected a comparatively great number of people in the industrial region, although at that time the attraction of industry (except for Budapest) could not yet rival that of the Sand Ridge of the Danube—Tisza Midregion with its developing vini- and horticulture, which exerted a much greater appeal, without causing, however, a material economico-occupational regrouping, merely a shifting of population from one agrarian branch to another.

After the First World War the areal changes of the productive forces began to show the symptoms of a real industrial development. From that time on, the internal migration of the population was markedly linked up with its economico-occupational restratification. The ratio of the agricultural population, which had been gradually losing its relative importance since the end of the nineteenth century, began to stagnate in absolute numbers as well during the interwar period. However, the rate of progress of urbanization fell far behind the rate of the occupational restratification (Fig. 1), though the concentration of population was proceeding at a quick pace. The number of localities with less than 1,000 inhabitants decreased considerably, as well as the total population concentrated in them (Table I).

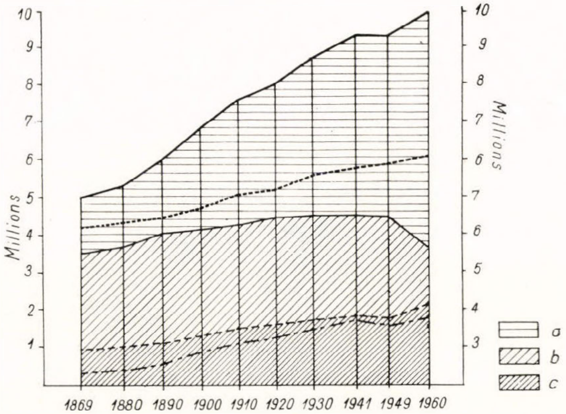


FIG. 1. Distribution of the population according to employment and settlement categories (towns and villages) between 1869 and 1960

a = non-agrarian population; b = agrarian population; c = population of the t wns in the country; ....village population —.—.— Budapest

TABLE I

Concentration of the population, 1930—1960

Number of inhabitants	1930		1941		1949		1960	
1	2	3	2	3	2	3	2	3
below 1,000	1,705	10.9	1,537	9.5	1,516	9.6	1,407	8.0
1,000— 5,000	1,440	34.2	1,473	33.3	1,511	34.8	1,581	34.1
5,000— 10,000	161	12.4	151	11.0	152	11.4	169	11.0
10,000— 20,000	66	10.0	78	11.0	62	9.0	70	9.4
20,000— 50,000	37	14.2	40	15.0	32	10.5	35	10.3
50,000—100,000	5	3.8	5	3.7	5	3.6	7	5.1
100,000—150,000	2	2.7	3	4.0	3	3.9	3	4.0
Budapest	1	11.8	1	12.5	1	17.2	1	18.1
Total:	3,417	100.0	3,288	100.0	3,282	100.0	3,273	100.0

1 = number of inhabitants; 2 = number of settlements; 3 = population of 2 against national total

In the course of the socialist industrialization between 1949 and 1960, the agricultural population so far stagnant started to shrink swiftly, and its number decreased by 940,000 (Fig. 1). The trend of internal migration was influenced, naturally, by the geographical distribution of the new productive forces and the new areal division of labour resulting from it. Because the territorial distribution of labour in Hungary, owing to the peculiar history of the national economy, was divided primarily into the Budapest area, as against the rest of the country, the migration caused conspicuous changes within this division, irrespective of the existence of some provincial industrial districts or foci. In fact, the stage of the social division of labour and the degree of its geographical differentiation have a strong influence on the volume, rate and trend of migration alike. Although during the implementation of the national plans for industrialization a somewhat more desirable distribution of industrial productive forces has been attained, the industrial predominance of Budapest has remained essentially unchanged; so that the capital continued to be the chief magnet for the internal migrants during the past decade. Between 1949 and 1960, 491,000 persons abandoned the villages. On the other hand, the urban population increased by 331,000, approximately 130,000 of whom came to Budapest. The difference between the number of out-migrants and in-migrants is due to the fact that 160,000 persons emigrated in the years 1956 and 57.

County Szabolcs-Szatmár, in the north-eastern corner of Hungary, which represents the greatest population reserve of the country, owing to the high birth-rates there, is the area losing most migrants. Similarly great numbers have migrated from the other regions of the Great Plain and from western Transdanubia. Budapest and its immediate surroundings, the districts of both Central Mountains—the centres of power production in Hungary known as the "Hungarian energy axis" — have attracted most migrating workers, but also other growing towns have absorbed a large share of migrants (Fig. 2).

The actual growth of population between 1949 and 1960 has been compared with the main trends of demographic evolution since 1869 (Fig. 3). During these nine decades, the number of inhabitants has increased in almost every region; in fact, the whole population has doubled. Exception must be made for the decrease in a southern district of county Baranya, as well as for the stagnating populations of South-East Transdanubia, the Danube—Tisza Midregion, the Pápa District on the West and the Hernád Valley on the North. Throughout the whole of Transdanubia the population has scarcely increased, likewise in the southern fringes of the Danube—Tisza Midregion and in the central part of the Trans-Tisza Region. The number of inhabitants multiplied at a striking rate in the capital and its surroundings, in many places of the Danube—Tisza Midregion, the Central-Tisza Region, the north-eastern Great Plain, in some further small spots of the south-eastern Great Plain, along the northern frontier, and in most towns and cities. In the areas not mentioned, the growth of population corresponded to the national average rate.

After 1949, the swift industrial development involved an economico-occupational restratification and a parallel spacial regrouping, which in many places intensified the prevailing tendencies of population growth, while in other places it, of course, had an opposite effect. In parts of Transdanubia and in the centre of the Trans-Tisza Region, the population, which formerly decreased slightly or stagnated or increased at an extremely slow rate, now began to show an over-all decrease, while in some areas near the capital and in a few towns it increased at a quickening pace. In contrast, in the Transdanubian Central Mountains, and in some districts of the Central

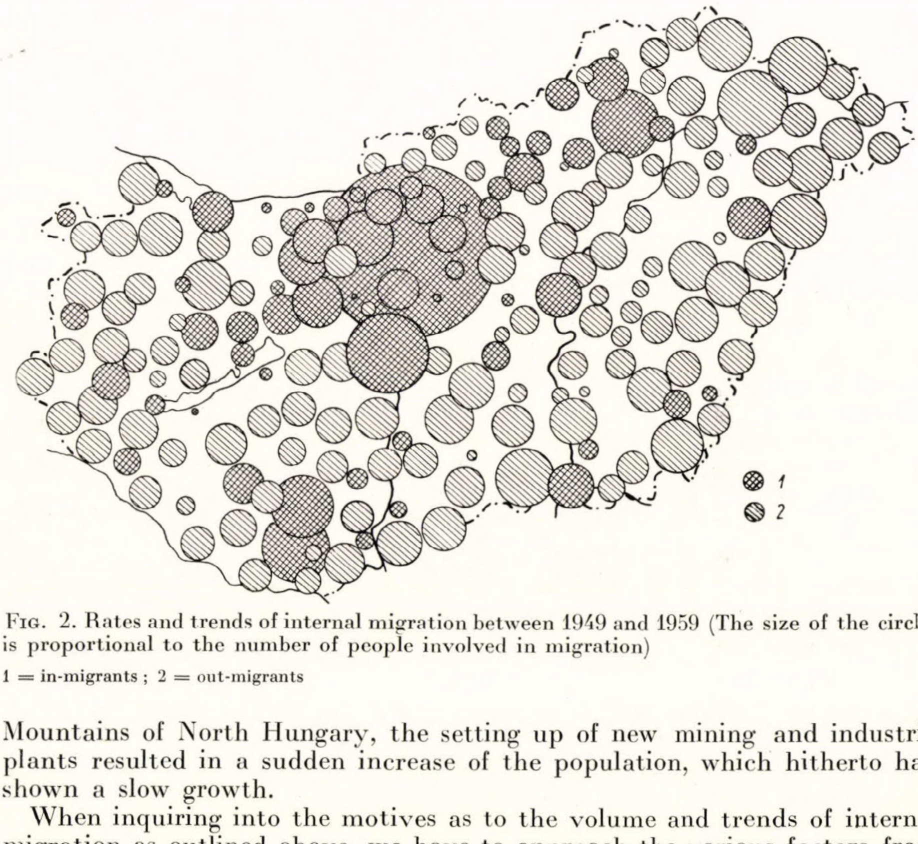


FIG. 2. Rates and trends of internal migration between 1949 and 1959 (The size of the circles is proportional to the number of people involved in migration)
1 = in-migrants ; 2 = out-migrants

Mountains of North Hungary, the setting up of new mining and industria plants resulted in a sudden increase of the population, which hitherto had shown a slow growth.

When inquiring into the motives as to the volume and trends of internal migration as outlined above, we have to approach the various factors from two angles. First we have to consider the circumstances causing overspill of population in a given region, then we have to examine those which, in turn, enable other areas to absorb people.

In so far as the areas of out-migration are concerned, it is the conditions and level of agricultural production that must be considered, since the migrants have come almost exclusively from the agricultural population. The number of the people that have migrated to towns (331,000) approximately equals that of the earners who have abandoned agriculture.

Two indices can be used for analysing the relationship between agricultural production and out-migration: the areality and the income per earner.

In computing the land ratio per agricultural earner, only the actual agricultural area was taken into consideration, and not according to the utilization forms (arable land, meadow, pasture, garden, vineyard), but by a reduction to arable units according to labour absorbed. In this way a more reliable reference to the number of earners could be obtained (1 arable unit = 1 ha of arable land, 0.2 ha of vineyard or garden, 5 ha of meadow, 10 ha of pasture,

FIG. 3. Shifts of population between 1869 and 1960

1 = decreased by 10%; 2 = stagnating (with an increase of 1 to 10%); 3 = increased by 10 to 50%; 4 = increased by 50 to 100%; 5 = increased by 100 to 200%; 6 = increased by 200 to 500%; 7 = increased by more than 500%; 8 = decreasing since 1949; 9 = rapidly increased since 1949

respectively). In places affected by large-scale out-migration, the areality is usually smaller than 4 ha per capita (without out-migrants!). And the lack of cropland affects a rather significant stratum, as in these areas 60 to 70% of the inhabitants live on agriculture.

Such an areality, naturally, can provide a very poor existence. In the areas mentioned the per capita income is the lowest in the country, namely half of that obtainable in the prospering regions (Fig. 4). These figures can partly be attributed to the mere physical conditions; the underdeveloped technique of farming, i.e. the surviving extensive forms of cultivation must also be considered among the causes, which, on the whole, are rather interconnected with the scanty education of the agricultural population in these areas.

No lack of employment in agriculture would induce the population to migrate, if the social division of labour were efficient enough to engage the surplus hands in other branches of economy. But as mentioned already, these almost entirely agricultural regions can offer industrial and other

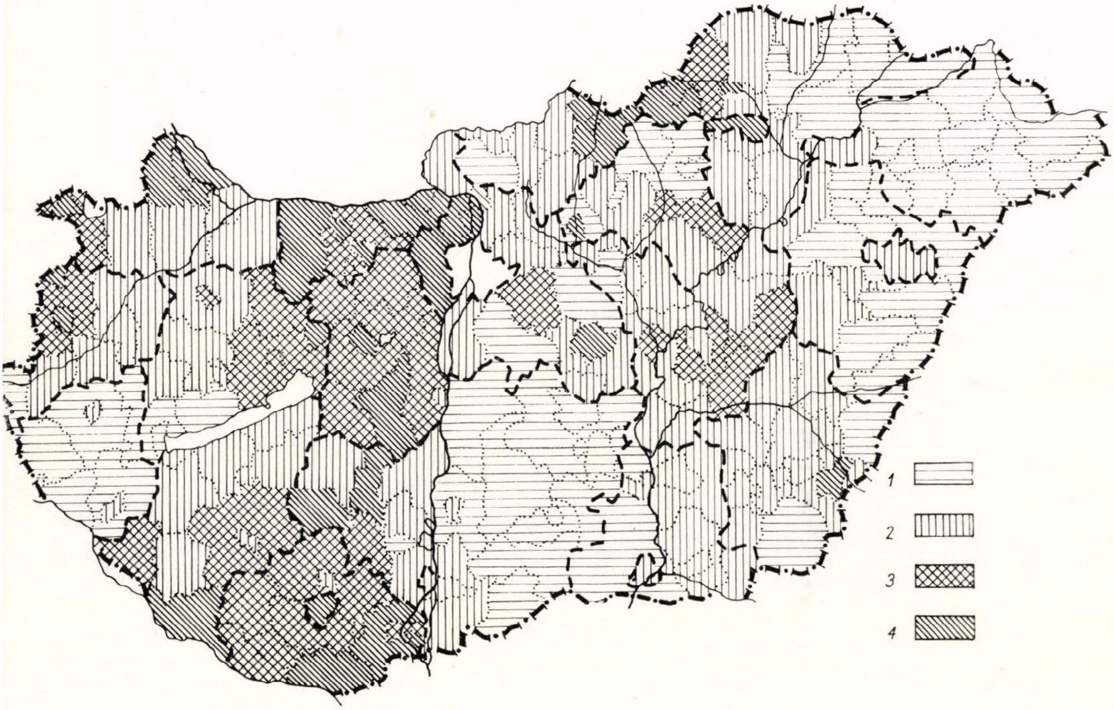


FIG. 4. Per capita production value of the agricultural population, without state sector (in 1,000 Fts/year)

1 = below 17.9; 2 = 18 to 21.9; 3 = 22 to 24.9; 4 = above 25

employment in a few towns only. The decade of industrialization could bring no real improvement either, since the capital invested in this period scarcely exceeded yearly 500,000 Fts for 1,000 inhabitants, whereas it made five or six times as much in the industrialized regions. For want of investments, the scope of non-agricultural working places could hardly increase. A simple comparison between the number of the newly-established non-agricultural working places and the natural growth in the last ten years, will show that less than 50 per cent of the natural increase can find jobs other than agricultural in many places of the areas in question. (In some places this figure varies from 50 to 70%.) It follows from the above that every second person entering his productive age can be engaged near his dwelling-place, the rest of the workers have been compelled either to out-migrate or to swell the local agricultural surplus labour. The major proportion of non-agricultural employment was offered not by the industry, but by the servicing or other branches of economy.

Although industrialization in the period between 1949 and 1960 was marked by some decentralization, it did not alter essentially the areal

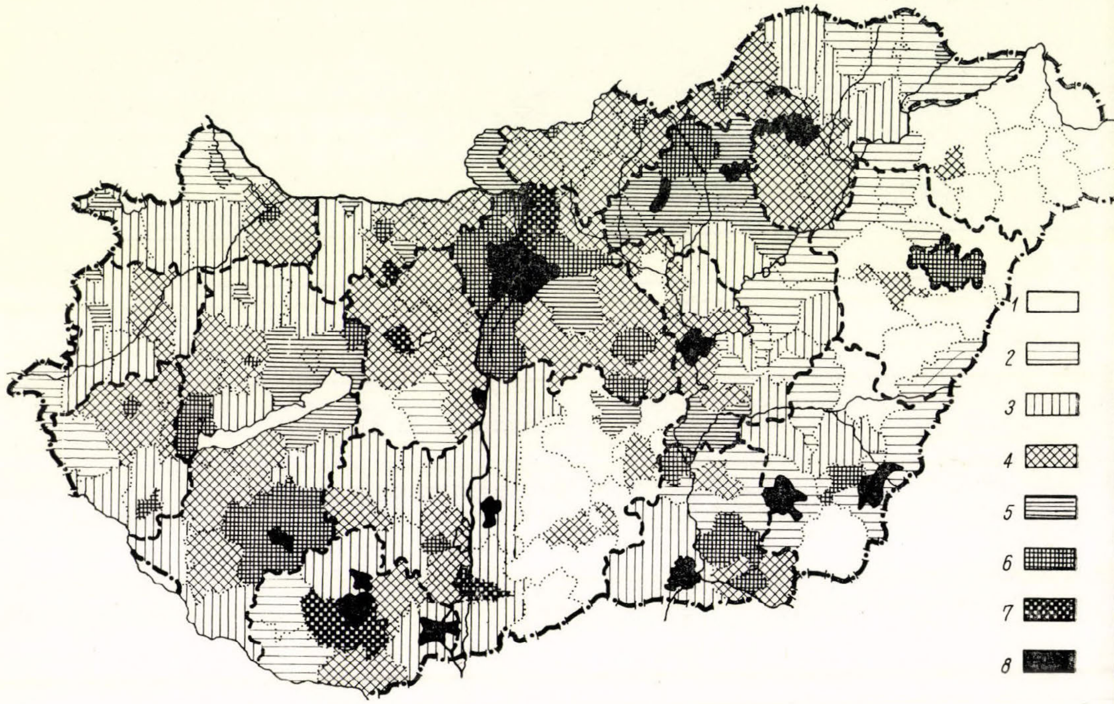


FIG. 5. Variation of the percentage of non-agricultural working places, with reference to new labour resulting from the natural increase

1 = below 50; 2 = 50 to 70; 3 = 70 to 100; 4 = 100 to 150; 5 = 150 to 200; 6 = 200 to 250; 7 = 250 to 300; 8 = above 300

structure of the productive forces. Internal migration invariably tended towards the capital and surroundings, and towards some regions with major mineral resources in the Central Mountains. In these areas, in spite of a relatively high natural growth and a considerable local manpower, a shortage of labour had been caused by the large-scale investments, the annual average of which amounted to 3 to 5 million Fts per 1,000 inhabitants in the decade of industrialization. Corresponding with this, the scope of non-agricultural employment augmented at such a rate that 200, and locally even 250 to 300 new working places fell on each

100 of new active population from the natural increase. The surplus working places were filled by migrants from other areas (Fig. 5). Owing to the great needs for industrial labour, the agrarian population decreased also much quicker here than in the areas not affected by the industrial development. In some municipal districts the agrarian population decreased by 30 to 40% between 1949 and 1960, and the actual agricultural labour by 40 to 50% (Fig. 6a,b).

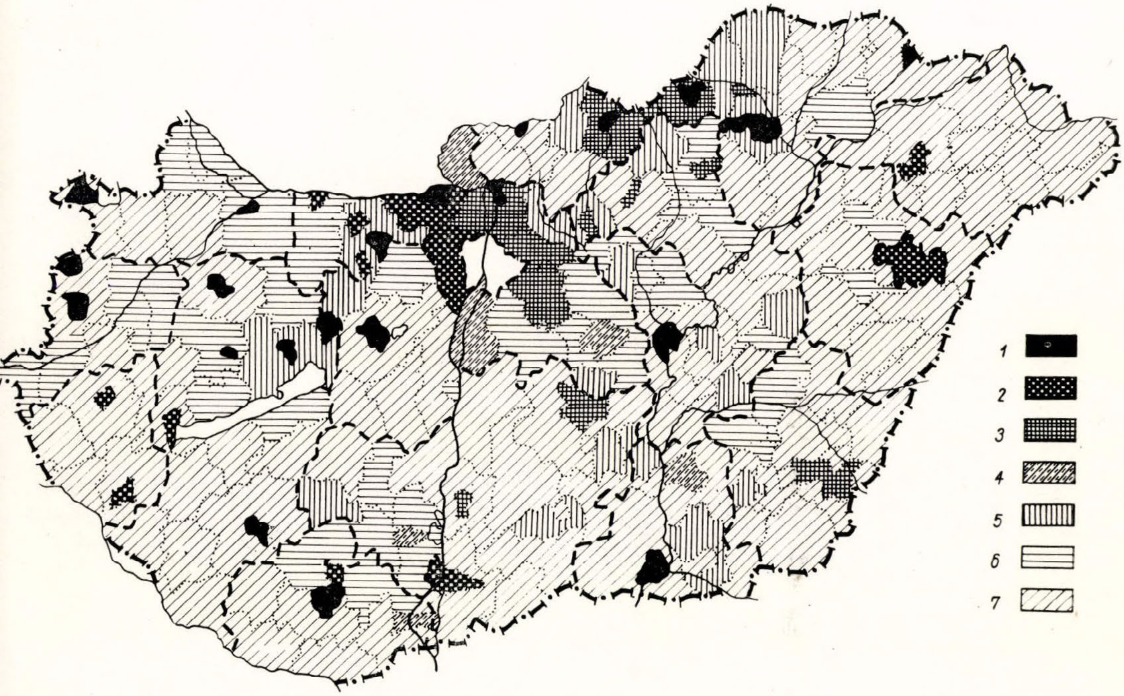


Fig. 6a. Ratio of agricultural population to total, 1949
1 = below 15%; 2 = 15 to 30%; 3 = 30 to 40%; 4 = 40 to 50%; 5 = 50 to 60%; 6 = 60 to 70%; 7 = above 70%

The yearly number of internal migration rose to some 600,000 in the middle of the fifties: in 1955 about 610,000 persons moved from one locality to another. In 1957 this figure amounted to 900,000 in consequence of the counter-revolution, and later on, between 1958 and 1961, settled at an average of 700,000.

The extremely complex process of such a large-scale areal regrouping brought about not only occupational restratification, but also multilateral changes in the demographical pattern of Hungary between 1949 and 1960. These changes are partly quantitative, partly qualitative in character.

(A) Quantitative changes:

(1) The density of population locally (counties Pest, Komárom) increased by 10 to 15 per km², while in other areas it decreased.

(2) The number of breadwinners decreased in the areas of out-migration by the same ratio as it increased in the areas of in-migration.

(B) Qualitative changes:

(1) Since the overwhelming majority of the migrants were young, the quantitative changes were connected with a substantial modification in the composition according to age of the population both in the

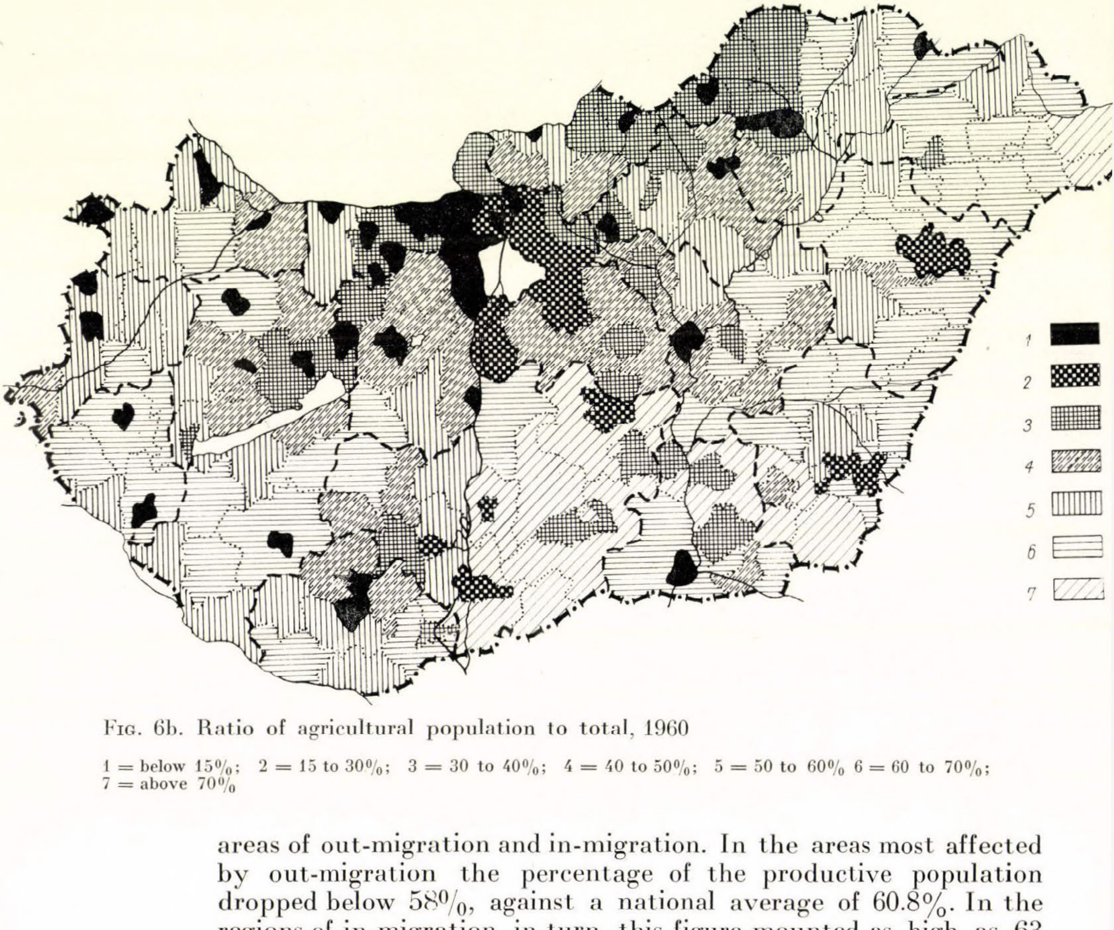


FIG. 6b. Ratio of agricultural population to total, 1960

1 = below 15%; 2 = 15 to 30%; 3 = 30 to 40%; 4 = 40 to 50%; 5 = 50 to 60% 6 = 60 to 70%; 7 = above 70%

areas of out-migration and in-migration. In the areas most affected by out-migration the percentage of the productive population dropped below 58%, against a national average of 60.8%. In the regions of in-migration, in turn, this figure mounted as high as 63 to 67% (Fig. 7).

(2) As the major part of the migrants were males, in the areas absorbing migrants the ratio of males rose suddenly over 48 to 49%, while in the areas losing population it declined proportionately.

(3) Migration as a rule trends from agricultural areas towards regions and towns in process of industrialization. This circumstance, in turn, modifies the earner/dependent ratio. In agricultural pro-

duction the male earner is aided by the grown-up females of the family, as auxiliary labour. Owing to migration to towns, a number of women, who were previously registered as earners in agriculture, became dependents because of the extremely limited scope for female employment; i.e. the number of gainfully occupied labourers decreases to a considerable extent. This process is shown in Fig. 8a–d, in which the ratio of agricultural earners

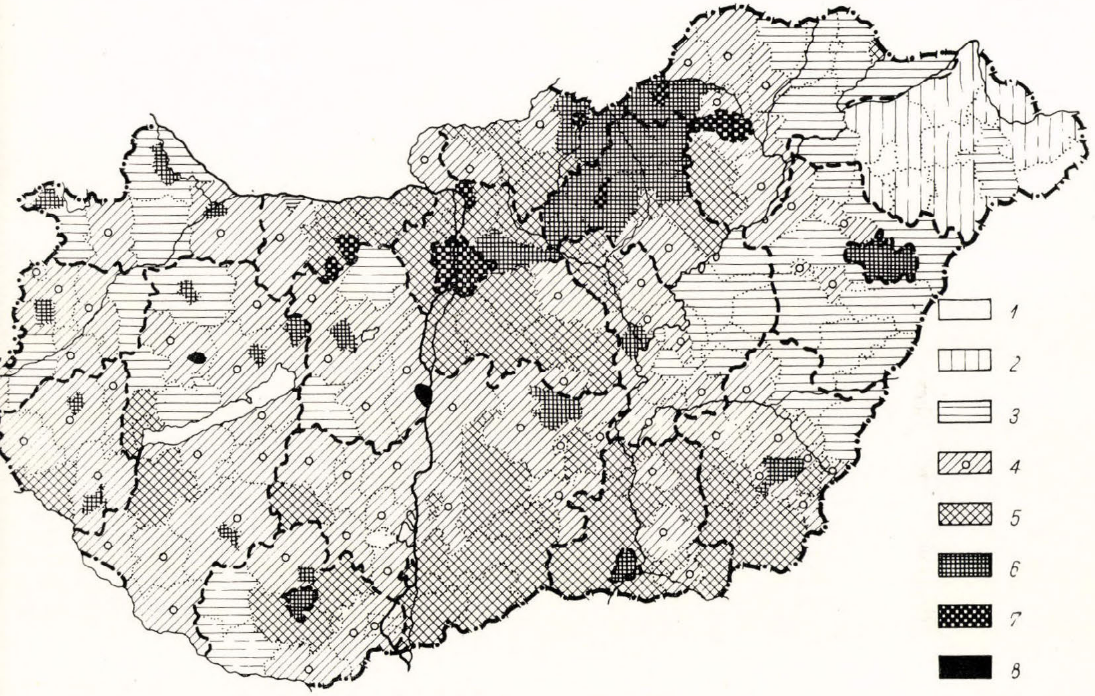


FIG. 7. Ratio of the productive population to total, 1960

1 = below 53.9%; 2 = 54 to 55.9%; 3 = 56 to 57.9%; 4 = 58 to 59.9%; 5 = 60 to 61.9%; 6 = 62 to 63.9%; 7 = 64 to 65.9%; 8 = above 66%

against non-agricultural ones is represented in age groups and sexes on a county scale. In agricultural areas the ratio of female earners is high, and so is the ratio of the earners over 60 years of age. In industrial areas the number of females is rather low, and that of the earners over 60 is not very high either. The figure for non-agricultural employees over 60 is relatively high only because the pensioners are listed as employees in the statistics.

The large-scale internal migration of the past ten years has been controlled by two vast economic processes: namely by the rapid industrialization and by the socialist reorganization of agriculture. As the two processes were not

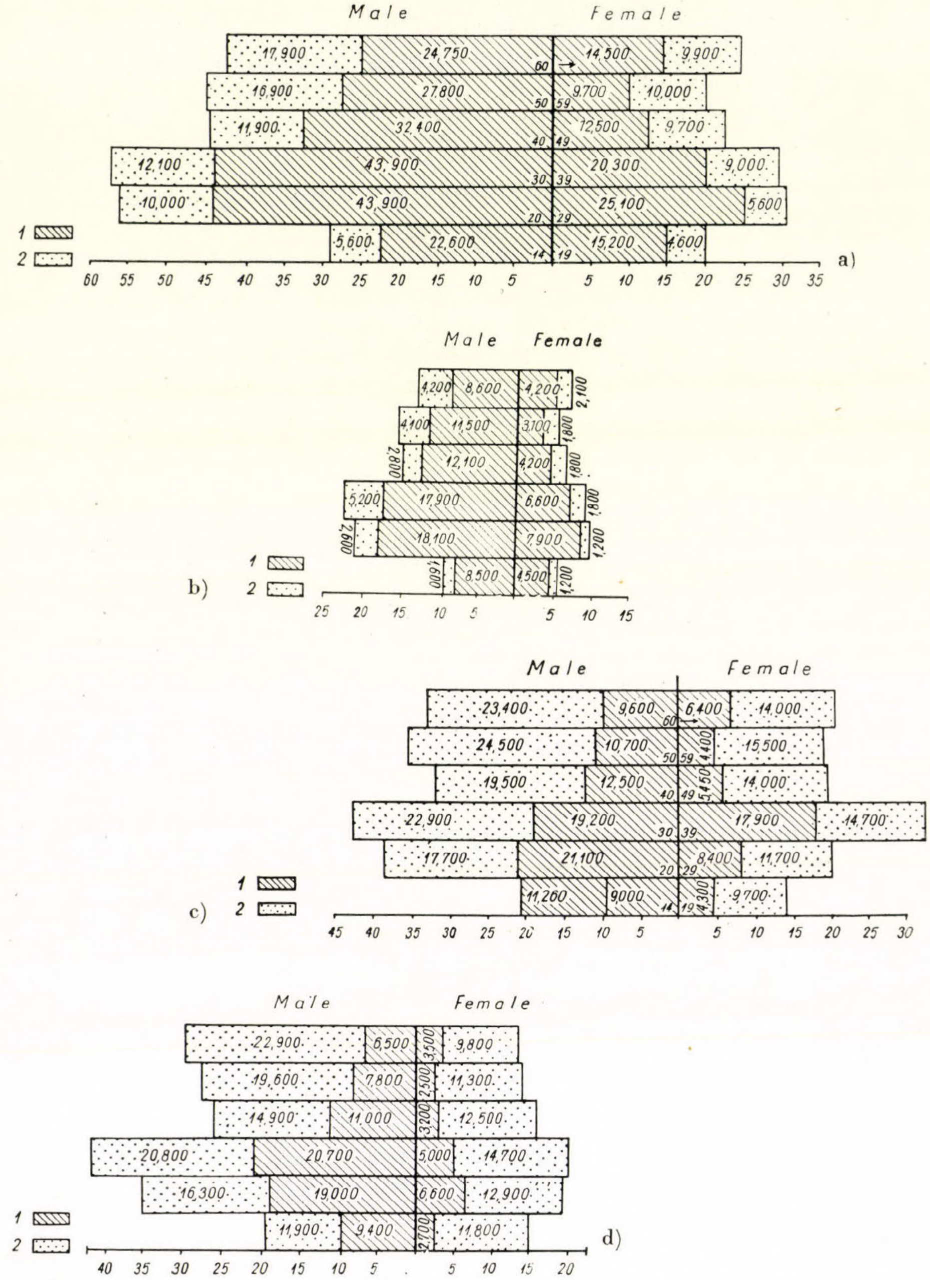


FIG. 8a—d. Distribution of the gainfully occupied population by branch, age and sex, according to model counties, 1960

a) = County Pest; b) = County Komárom; c) = County Bács-Kiskun; d) = County Szabolcs-Szatmár. 1 = = agricultural earners; 2 = non-agricultural earners always synchronous, the occupational restratification of the population could not proceed smoothly. Sometimes some shortage of labour was felt in industry, sometimes in agriculture. And although the labour demand is now becoming more and more moderate in industry, the movement has not yet been balanced at all. Apart from the labour needed in industry, more and more workers are required by the so-called servicing branches and special establishments; at the same time, further release of manpower is to be expected as the result of the subsequent modernization and mechanization of agriculture.

Considering the actual distribution of productive forces, the relative congestion in the agricultural areas and the high natural increase of the agrarian population, the present-day trends of internal migration are to be reckoned with as lasting for a long time. According to the development of Hungarian national economy during the past ten years and the progress it is likely to make according to the plan for the coming years, the production areas of Hungary may be divided into two main categories: (1) regions having a primary, active function in improving the social division of labour, and (2) regions with secondary, passive function. Of course, there are considerable divergencies within each of the two categories, only the main trends being the same. An intense concentration of investments has resulted in a striking contrast between the areas receiving large investments, and the areas in which less funds have been invested.

In terms of intensity of economic activity, the territory of Hungary may be divided into the following zones (Fig. 9):

(1) *Areas with intensive industrial activity, absorbing labour*

These areas received 85% of total investments between 1950—1960, which accounted for approximately 35 million Fts per 1,000 inhabitants. In consequence of these investments, 200 non-agricultural working places fell on each hundred of active population from the natural increase. Since 1949 the population has shown a rapid increase. One reason for this is a 12% natural growth; a second one is due to a migration surplus of $12—15\%$. About 35 to 40% of the population of these areas is employed in industry, and approximately the same in agriculture. The percentage of productive population is considerably higher here than in the national average, and female labour has risen to significant proportions in the non-agricultural branches of economy. These areas form a continuous zone, crossing the country from SW to NE, irrespective of the industrial region in county Baranya.

(2) *Overpopulated agricultural areas of moderate economic activity, releasing labour*

These areas, forming a semicircle around the industrialized zone discussed above, are far from being homogeneous. A characteristic feature of this belt is that the agricultural population is about 60% of the working force and the proportion of productive population thus falls below the national average. In fact, in the first place permanent out-migration decreases the number of the young, so the composition of population according to age shows considerable "aging". This process is controlled by two main components: the natural growth is relatively high in most of these areas, particularly in the North-East, whereas only 15% of the 1949—1960 investments has been allotted to them. At the same time, the percentage of the non-agricultural working places as related to natural increase of population is amazingly high in the western half of the zone (70—100), while in the Danube—Tisza Midregion and the northern part of the Trans-Tisza Region, which show the most rapid

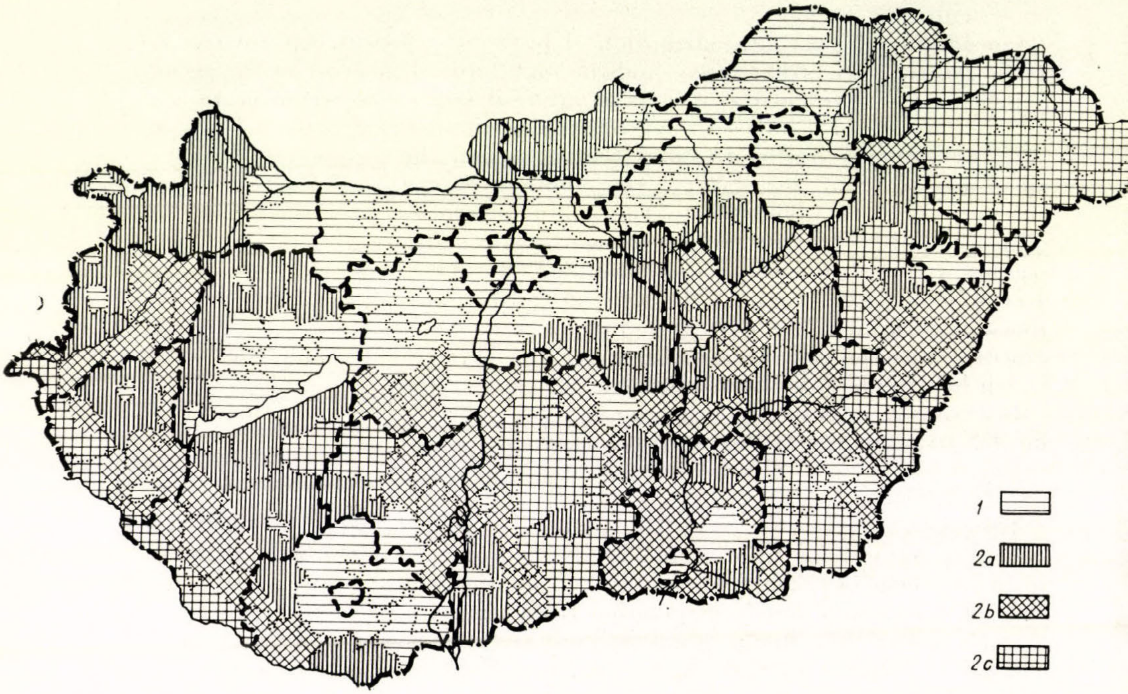


FIG. 9. Relationships between investments, labour, economic activity and migration in Hungary, 1949—1960

1 = Industrialized areas with labour requirements considerably exceeding the rate of natural increase, with high ratio of active population, and with investment 36 million Fts per 1,000 inhabitants from 1950 to 1960

2a = slightly decreasing population, moderate industrialization
2b = decreasing population, poor industrialization
2c = high natural increase, mass out-migration, hardly any industrialization

areas with overspill population, releasing people, with low ratio of productive population and with investments of 7 million Fts per 1,000 inhabitants, from 1950 to 1960

natural increase, it is less than 50. This is the reason why out-migration is the highest here, exceeding 15%. A further characteristic of the zone is that women and males over 60 make up a very large proportion of the agricultural earners.

It is quite likely that Hungary's territory will be divided according to these two peculiarities (out-migration and in-migration) of economic development for a long time to come. Although considerable efforts are made in order to intensify the agriculture of the overpopulated areas, even intensive farming will not be able to absorb all surplus labour from year to year. Some decrease in the volume of migration is, however, to be expected, as the number of servicing branches and establishments increases, as a concomitant of the rising standard of living, and will require more labour than at present. At all events preparations for some degreed industrialization are being made in these underdeveloped areas, too.

Bibliography

Acsádi, Gy. (1956) A népesség belső vándorlása (Internal migration of the population), *StSz*, no. 5, 451–62

Danyi, D. (1962) A beruházások hatása a belső vándorlásra (The effect of investments on internal migration), *Dem.*, no. 4, 554–7

Kiss, A. (1961) Az agrárnépességi viszonyok területi alakulása Magyarországon 1880–1960 (Changes in the areal distribution of the agrarian population between 1880–1960), *Dem.*, no. 1, 50–90

Pálfai, I. (1963) A mezőgazdaság munkaerőhelyzete (Labour conditions in agriculture), *StSz*, no. 2, 115–37

Szabady, E. (1962) A társadalmi-foglalkozási átrétegződés és demográfiai hatásai (Social-occupational restratification and its demographic effects), *Dem.*, no. 4, 494–9

URBANIZATION OF HUNGARY IN THE LIGHT OF THE OCCUPATIONAL STRUCTURE OF HER POPULATION

by EDIT LETTRICH

The structural transformation of economy, which brings about an increasing demand for labour in the industrial and other non-agrarian branches of production, plus the decreasing needs for agricultural labour, and the concentration of the working places open a new stage of development in the urbanization of Hungary.

In contrast to the relatively dense and uniform distribution of the agricultural working places and to their poor areal concentration, the non-agrarian working places employing an increasing proportion of the breadwinners of Hungary are characterized by a considerable areal concentration and very uneven distribution. This holds particularly true of the large-scale manufacturing industry which absorbs the greatest number of hands. Owing to a new pattern of agriculture and an intensive concentration of non-agrarian working places a great number of settlements can no longer perform the function of a working place for the country-dwellers. Consequently, the process of disjunction of the working places from the dwelling places is intensifying.

The towns cannot develop in a uniform way, and the process of urbanization varies from region to region, depending on geographical features and the local peculiarities of the settlement network. To examine this process and to detect its geographical particularities is the objective of the present essay.

Method used for the study of urbanization

The interconnections between the transformation of the national economy and the occupational restratification of the population, on the one hand, and urbanization, on the other, suggest the method: to draw conclusions from the occupational structure and from the areal differentiation of the working and dwelling places as to the process and characteristics of urbanization.

The great number of settlements to be studied made it necessary to distinguish various types. The economic types of the municipal localities, being confined to the characteristics of the spatial structure of economy, can provide no reliable information on the occupational conditions of the inhabitants. Therefore the occupational structure of the inhabitants was used for establishing various types of localities, according to the method of H. Fehre (1961).

This method of typology is based on three main groups of the occupational branches: (1) agriculture; (2) industry (all the branches of mining, energetics, building, manufacturing and small-scale industry); (3) "other" branches*

* In the rest of this paper "other" branches will be used in this meaning.

(communications, trade, public service, all the utility services, etc.). The three main groups embrace all the breadwinners.

Fehre established his types in studies of settlements in Rhine-Westphalien, the most industrialized region of Germany, relying on the division of the economically active population among the three major groupes. For this purpose he applied the triangular diagram earlier used by several authors.

We could not adopt his method in the same form as he applied it, primarily because the objective of our research was different from his. Fehre aimed at determining the economic types of the resident population. We, however, have attempted to illustrate the geographical distribution according to the movement of the agrarian and non-agrarian population, i.e. the population in transition to urbanization, as it is one of the characteristics of the process of urbanization. Consequently, the contents and the interpretation of the types of communities distinguished by Fehre and by us are *a priori* different. Difference results also from the fact that in determining the types we chose threshold values other than Fehre did. This is warranted by the substantial differences existing between the economico-social structure and history of the two areas examined (Westphalien and Hungary). Like Fehre, we also established empirically the threshold values delimiting the types of communities, striving to reflect the true conditions in Hungary.

The main types (Fig. 1) are as follows:

I. *Agrarian types* = in which the percentage of agrarian breadwinners is higher than 55%

II. *Mixed types* = in which the proportion of agrarian breadwinners ranges from 37 to 55%

III. *Mainly non-agrarian types* = in which the proportion of agrarian breadwinners ranges from 15 to 36%

IV. *Markedly non-agrarian types* = in which the proportion of agrarian breadwinners ranges below 15%.

All main types, except the agrarian ones, are regarded as localities either urbanized or in transition to urbanization (transition localities), since the majority of their inhabitants do not conduct any agrarian activity and the rest are gradually losing connection with agricultural production.

The localities of the mixed type (II) stand at the lowest stage of urbanization. Agriculture still has a leading role in the occupational structure, but the percentage of industrial bread-winners approximates, or is only slightly inferior to that of the agrarian ones.

The type in the second stage of urbanization (III) is already unambiquously non-agrarian in character, as 63 to 85% of the breadwinners have a non-agrarian occupation. Nevertheless, industry or "other" branches have not yet completely superseded the agricultural activities.

The localities in the third stage of urbanization (IV) have reached, or got close to the peak of development, as their agrarian population has been almost completely absorbed. Any further changes in their occupational structure may take place only through the modification of the proportion between industry and "other" branches.

Further on, we determined the foci of industrial working places, i.e. the regional centres of industrialization which control the process of occupational restratification. In doing so, we relied on the degree of commuters' traffic. Such industrial working places where the excess of incommuters against out-commuters was more than 100 were considered as labour-absorbing centres. In contrast, the industrial working places mainly engaging local inhabitants were ranked as places of poor labour absorption. This latter

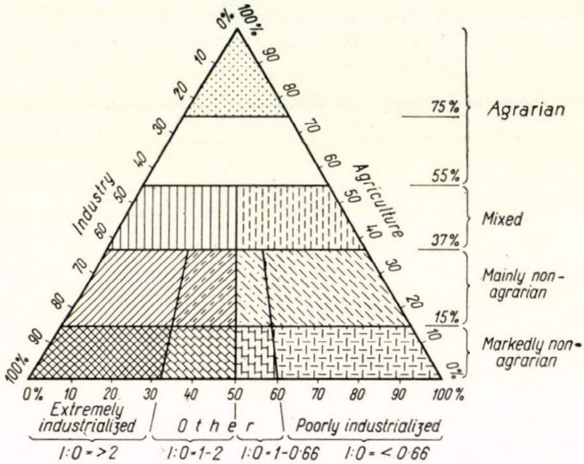


FIG. 1. Triangular diagramme indicating the structure of population by economic division

category comprises industrial plants employing more than 250 workers, including a surplus of in-commuters. 1 to 100 localities with excess of out-commuters, the number of which did not exceed that of the local industrial workers, were also included in this category, provided the employees in the local factories totalled more than 250.

By the differentiation of these two principal types of working places—centres employing mainly commuters and those working with mostly local inhabitants—the transition localities of residence character have also been determined. The non-working place localities mostly coincide with the dwelling localities of out-commuters. Their commuting balance is regarded as negative, in contrast with the commuting balance of the working place centres, which is positive.

The village and town types as determined by the above method — and the distinction of the settlements with working place character from those with residence character — permit us to examine the process of urbanization, with a view to the hierarchical features of the settlement network.

Transformation of the occupational structure owing to the structural changes in national economy

Agricultural dominance of the national economy was eliminated at a very quick pace. Between 1949 and 1960 the proportion of the agrarian breadwinners decreased by about 20%. To-day agriculture provides means of subsistence for 300,000 less labourers than did 10 years ago. The sudden decline of the agrarian ratio is partly due to the erroneous peasant policy

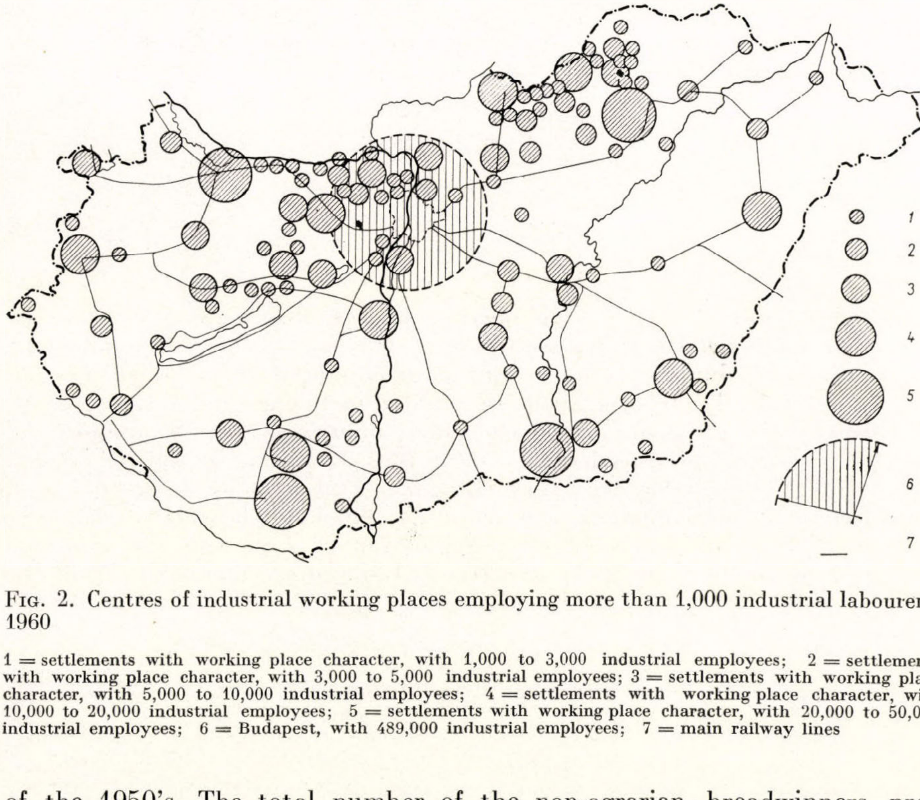


FIG. 2. Centres of industrial working places employing more than 1,000 industrial labourers, 1960

1 = settlements with working place character, with 1,000 to 3,000 industrial employees; 2 = settlements with working place character, with 3,000 to 5,000 industrial employees; 3 = settlements with working place character, with 5,000 to 10,000 industrial employees; 4 = settlements with working place character, with 10,000 to 20,000 industrial employees; 5 = settlements with working place character, with 20,000 to 50,000 industrial employees; 6 = Budapest, with 489,000 industrial employees; 7 = main railway lines

of the 1950's. The total number of the non-agrarian breadwinners progressively increased in the same period. It was due, on the one hand, to an influx of the excess of agrarian population into the industrial working places and, on the other hand, to the considerable amplification of female employment, mostly in the non-agrarian branches. (Fig. 2)

The geographical distribution of the industrial working places exhibits two characteristic features. (1) Industry is predominantly concentrated in the capital; 45% of the industrial labourers of Hungary are employed in Budapest. The towns of major industrial concentrations, Miskolc, Győr, Szeged and Pécs engage in industry only 20,000 to 40,000 employees each. Among them, Miskolc and Győr are comparatively significant centres of in-commuting,

TABLE I

Distribution of the industrial working places in terms of employees (mining and manufacturing industry, 1960)

Industrial working places	Industrial employees			
	number	%	commuters number	%
1. Budapest Agglomeration	523,205	48.0	113,923	21.8
2. Northern- and Central-Transdanubian Heavy-Industry District	93,633	8.6	42,163	45.1
3. Győr	27,669	2.6	10,627	38.4
4. Baranya Industrial District	35,933	3.4	9,915	27.6
5. Nógrád and Borsod Heavy-Industry District	117,391	11.0	65,769	56.2
Total 1 + 2 + 3 + 4 + 5	797,831	73.6	232,397	29.1
6. Scattered, isolated working places	286,485	26.4	59,535	20.7
Total Hungary	1,084,316	100.0	291,932	26.9

while Szeged and Pécs, employing mostly residents, absorb a very low number of industrial labourers from the countryside. (2) There are no medium industrial centres. The number of the industrial foci employing 5,000 to 20,000 persons is not more than 11. Most of them are situated in Transdanubia. Conspicuous is, however, the great number of the minor industrial foci, the majority of which are centres of considerable commuting. In the areas of the Central Mountains — the mining regions of Hungary — these minor industrial foci, absorbing considerable labour, are densely situated side by side.

Two-thirds of Hungary's industrial population are working in the industrial plants along the Danube and in the Hungarian Central Mountains. Thus the

TABLE II

Distribution of the population among towns, transition localities and villages from 1949 to 1960

	1949		1960		Difference between 1949 and 1960
	inhabitants	%	inhabitants	%	1949 = 100
1. Population of villages	4,639,767	50.4	3,448,914	34.6	74
2. Population of transition localities	1,175,097	12.7	2,564,955	25.7	218
Total 1 + 2	5,814,864	63.1	6,013,869	60.3	110
3. Population of towns (without Budapest)	1,800,870	19.6	2,155,362	21.6	120
4. Population of Budapest	1,589,065	17.3	1,807,299	18.1	113
Total 2 + 3 + 4	4,565,032	36.9	6,527,568	39.7	143
Total population of Hungary	9,204,799	100.0	9,976,530	100.0	108

geographical distribution of the industrial working places is extremely uneven, which has a significant impact on the areal patterns of the occupational restratification, too.

Owing to the varied pattern of industrialization, as well as to the regional differences of the settlement network, the occupational regrouping, i.e. the influx from agriculture into industry, did not proceed everywhere in the same way. According to the nature of migration, three main forms of this

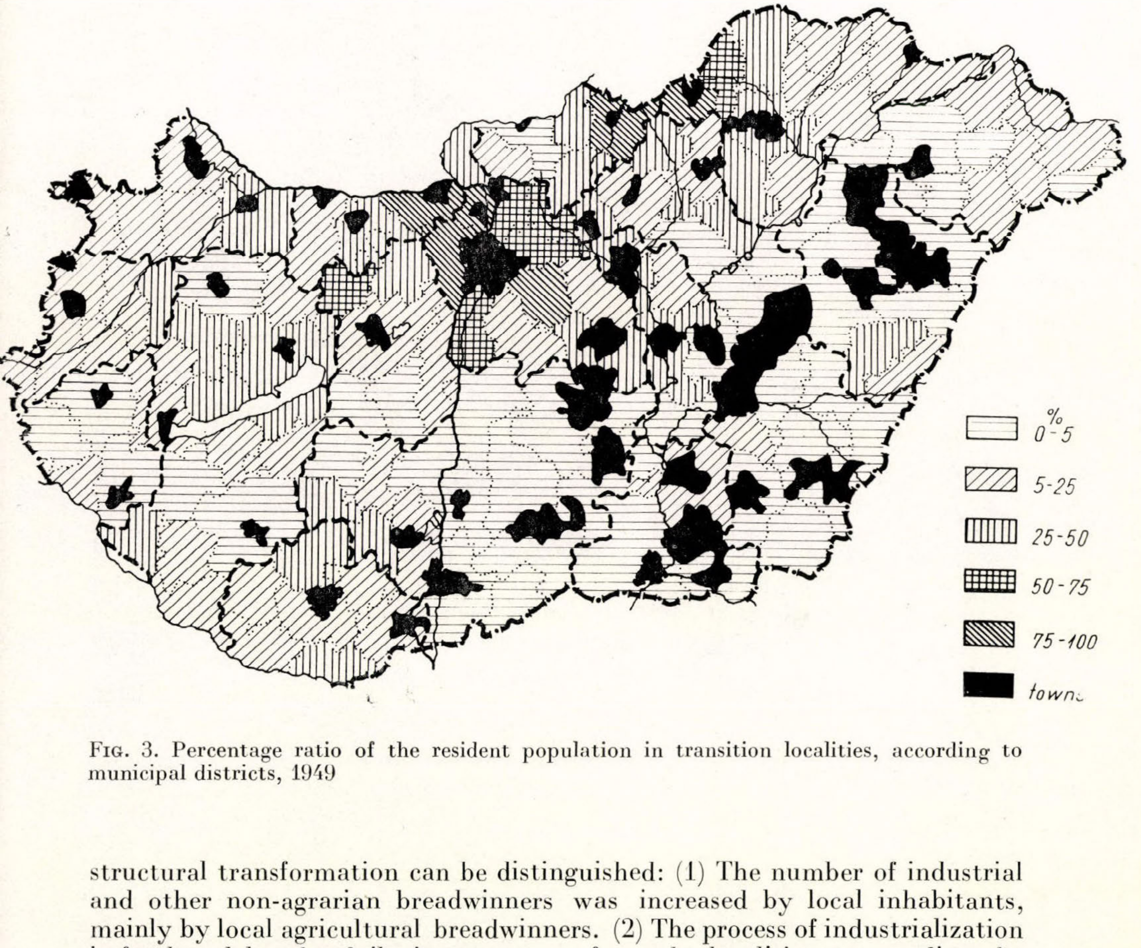


FIG. 3. Percentage ratio of the resident population in transition localities, according to municipal districts, 1949

structural transformation can be distinguished: (1) The number of industrial and other non-agrarian breadwinners was increased by local inhabitants, mainly by local agricultural breadwinners. (2) The process of industrialization is furthered by the daily in-commuters from the localities surrounding the industrial centre. (3) The surplus of agrarian population migrates towards and settles in the industrial centres. These processes take place synchronously, but do not affect the masses to the same extent. In the present process of industrialization commuting has played the decisive role. The concentration has largely influenced the growth of Budapest and some other cities, but did not result in country-wide urban concentration. The current phase of industrialization is characterized by a large-scale restratification of the rural population, which, in turn, directs attention to the transition localities. (Fig. 3, 4)

As seen from the figures, the group of the transition localities, i.e. those non-agrarian ones with less than 55% agricultural breadwinners, had a striking numerical growth between 1949 and 1960, irrespective of the progress they made in the way of occupational restratification.

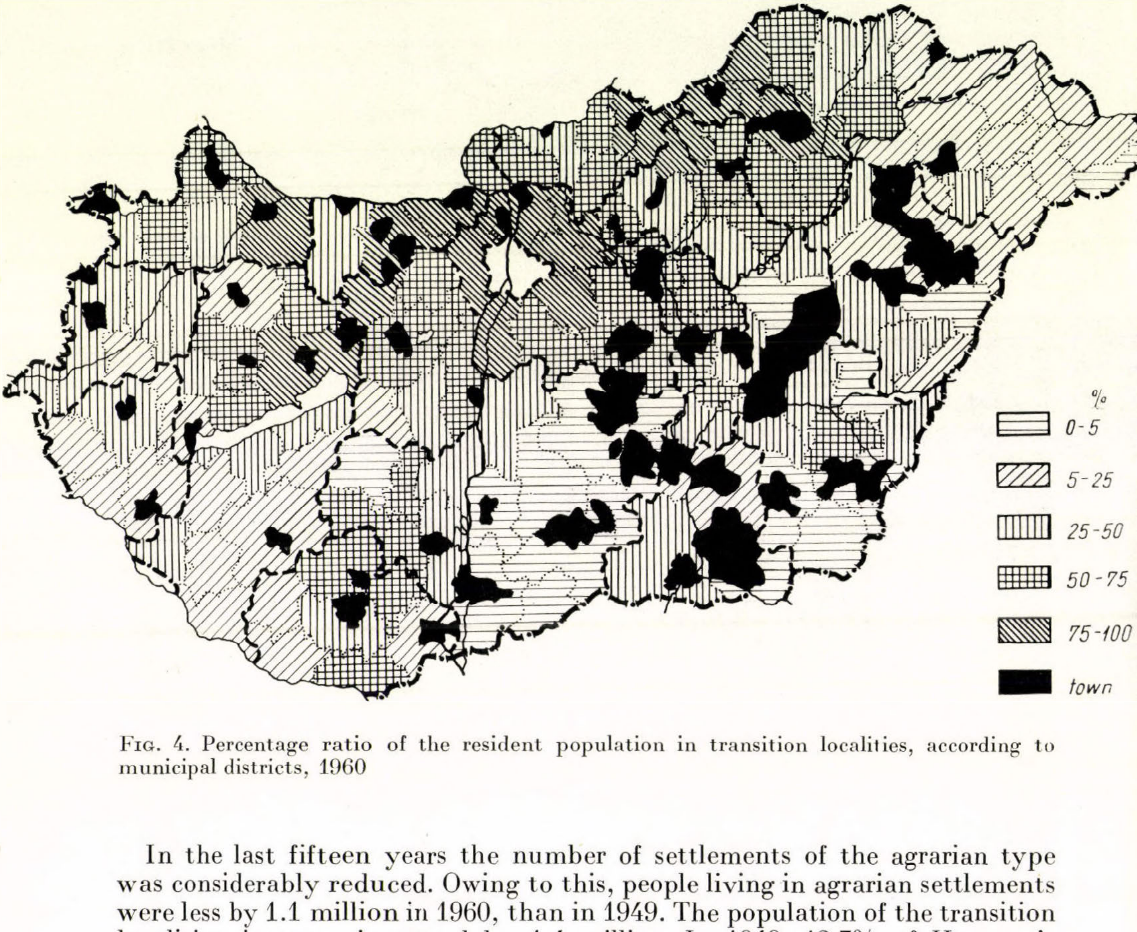


FIG. 4. Percentage ratio of the resident population in transition localities, according to municipal districts, 1960

In the last fifteen years the number of settlements of the agrarian type was considerably reduced. Owing to this, people living in agrarian settlements were less by 1.1 million in 1960, than in 1949. The population of the transition localities, in turn, increased by 1.4 million. In 1949, 12.7% of Hungary's population lived in transition localities, in 1960, their proportion already amounted to 25.7%. Their population is greater than the total of all provincial towns. This fact also indicates their growing importance in the process of urbanization. Consequently, it does not suffice to examine urbanization only in relation to the development of the towns. The transition localities of Hungary participate in this process on a par with the towns (Table III).

TABLE III

Regional distribution of the population among towns, transition localities and agrarian villages, 1949—1960

	1		2		3		4		5	
	agrarian villages		transition localities		towns		total population		towns + transition localities	
	number	%	number	%	number	%	number	%	number	%
Transdanubia										
1949	1,862,536	67.2	412,693	14.9	495,583	17.9	2,770,812	100	908,276	32.8
1960	1,258,345	41.8	972,441	32.3	781,090	25.9	3,011,876	100	1,753,531	58.2
Difference between 1949 and 1960	—604,191	—25.4	559,748	17.4	285,507	8.0	241,064	8.7	845,255	25.4
Great Plain										
1949	2,158,317	58.6	462,266	12.5	1,063,109	28.9	3,683,692	100	1,525,375	41.4
1960	1,800,802	46.8	1,002,902	26.1	1,042,137	27.1	3,845,841	100	2,045,039	53.2
Difference between 1949 and 1960	—357,515	—11.8	540,636	13.6	—20,972	—1.8	162,149	4.4	519,664	11.8
North										
1949	618,914	53.3	300,138	25.8	242,178	20.9	1,161,230	100	542,316	46.7
1960	389,767	29.7	589,612	45.0	332,135	25.3	1,311,514	100	921,747	70.3
Difference between 1949 and 1960	—229,147	—23.6	289,474	19.2	89,957	4.4	150,284	13.0	379,431	23.6
Budapest										
1949							1,589,065		1,589,065	
1960							1,807,299		1,807,299	
Difference between 1949 and 1960							218,234	13.7	218,234	
Total Hungary										
1949	4,639,767	51.4	1,175,097	12.7	3,389,935	36.9	9,204,799	100	4,565,032	49.6
1960	3,448,914	34.6	2,564,955	25.7	3,962,661	39.7	9,976,530	100	6,527,616	65.4
Difference between 1949 and 1960	—1,190,853	—15.8	1,389,858	12.9	572,726	2.8	771,731	8.4	1,962,584	15.8

In the past fifteen years *Transdanubia*, which previously had the scarcest town network in Hungary, showed the most marked rate of urbanization. The number of the towns amounted from 17 in 1949 to 24 in 1960, and the urban population in them rose from 18% to 30%. The transition localities display a similar progress. Approximately 50% of the transition localities of Hungary are found in Transdanubia, where they surround the more evenly distributed industrial plants in swarms. A dense railway and highway network have also contributed to the rapid influx of the agrarian population. So between 1949 and 1960 the population of the towns and transition localities increased from 908,276 to 1,753,531, i.e. by nearly 100%; 58.2% of the total population are now residents of towns and transition localities. This process was confined mostly to the northern half of Transdanubia; in the southern part urbanization covers only minor spots.

North Hungary (counties Nógrád, Heves and Borsod) was the best urbanized part of the country until 1949. Today the majority of its population lives in the urban agglomeration of Miskolc, and in the urban-type localities clustered near the minor and medium centres of mining and heavy industry at Ózd, in the Sajó Valley, and Nógrád. 70.3% are inhabitants of non-agrarian settlements. The agrarian villages thereabouts showed the most pronounced decrease in that the number of their inhabitants dropped from 53.3% to 29.7% in the last decade. The ratio of the population of transition localities to the total of the region rose from 25.8% to 45%, while that of towns rose from 20.9 to 25.3%. So, the increase in towns was 4.4%, in contrast to a 19.2% growth in the transition localities. Next to Budapest, this territory of North Hungary exhibited the highest population increase (13%), owing mainly to the influx from the adjacent Great Plain areas.

In the *Great Plain* the concentration in towns was very much advanced as far back as the 19th century. This part of Hungary is the most abundant in towns, but — with the exception of Debrecen, Szeged and Szolnok — they are poorly industrialized market-towns, where no industry whatever was developed prior to the introduction of socialist industrialization. Nor did the last fifteen years bring any substantial change in this respect. 35 to 60% of the population of these towns are agricultural breadwinners. Situated in the midst of vast agricultural areas, these market-towns concentrate the population in a different way than the foci of industrial working places in Transdanubia and the North. They are ranked as towns only because of the number of dwelling places they provide for a large number of people (35,000 to 50,000). The peasants of the scattered farmsteads gradually move into the towns. This process being intensified by the mechanization of agriculture and still further home-concentration is to be reckoned with. Also, large-scale socialist agriculture brings about a sort of agricultural commuting, which — in contrast to industrial commuting — is connected with the concentration not of working places but of homes. Industrialization is still in its initial stage in the Great Plain, and its scanty power, water, and mineral resources can make only a poor contribution to the national programme. Light and food-processing industries — though considerably behind the heavy industries today—may, together with the unfolding large-scale farming, open a new phase of urbanization on the Great Plain.

Types of settlements and their geographical distribution

In the foregoing we have assessed the stages of urbanization, considering the proportion of the economically active agrarian population (types II to IV). A more detailed survey of the occupational structure of the transition communities provides data for further analysis. The question whether the inhabitants of these communities make their living primarily by industrial or "other" non-agrarian activity may be answered also by Fehre's method of determination of subtypes. This method essentially consists in inferring the economic motivation and genesis of urbanization from the ratio of the inhabitants regularly employed in industry (I) to those employed in "other" economic divisions (0). According to these ratios for transition settlements (types II to IV), the following subtypes can be distinguished:

subtype *a*	I : 0	= more than 2
,, *b*	I : 0	= 1 to 2
,, *c*	I : 0	= 0.66 to 1
,, *d*	I : 0	= less than 0.66

Subtype *a* is a settlement with highly industrialized inhabitants, while subtype *d* is poorly industrialized. Subtypes *b* and *c*, where the proportions of the inhabitants in industrial and "other" occupations are approximately equal, represent transitions between these two extremes. The stages of development, as can be read off the triangular diagram in Fig. 1, show progress from extreme conditions towards more balanced ones.

According to the census taken in 1960, the 3210 villages and 63 towns of Hungary show the following distribution (Fig 5):

(1) The category of the settlements of *agrarian character* comprises 70.5% of the settlements of Hungary, i.e. 2288 villages and 3 towns (Hajdúböszörmény, Hajdúnánás, Túrkeve). From the centre of the country towards the borders, their number gradually increases. Their wide, continuous semicircular zone surrounds the area of the non-agrarian settlements. It covers the areas of small villages in the southern part of the Danube—Tisza Midregion (which is rather poor in communication facilities) as well as the border of the country. In most of these settlements more than 75% of the inhabitants subsist on agriculture. As one proceeds towards the centres of industry, this continuous agricultural zone becomes disintegrated because of the appearance of urban settlements of mixed and more developed types.

The agrarian settlements, in spite of their great number, comprise only 35 of the population of Hungary. Most of them have less than 1,000 inhabitants; extremely rare are the settlements whose population exceeded the rate of natural increase in the last decade, for almost all of them are places of degrees of emigration. The settlements with less than 500 inhabitants exhibit nearly everywhere a marked decrease, which foreshadows their gradual liquidation.

(2) The settlements of *transition character* (I. mixed, II. mainly non-agrarian, and III. markedly non-agrarian) form the dwelling and working places of 65% of Hungary's population. They are considerably less in number (932 villages and 60 towns) than the agrarian ones. 95% of the cities and

towns and $43^0/_0$ of the villages belong to this category. Their territorial distribution is largely confined to the industrial working place centres and to the arterial roads.

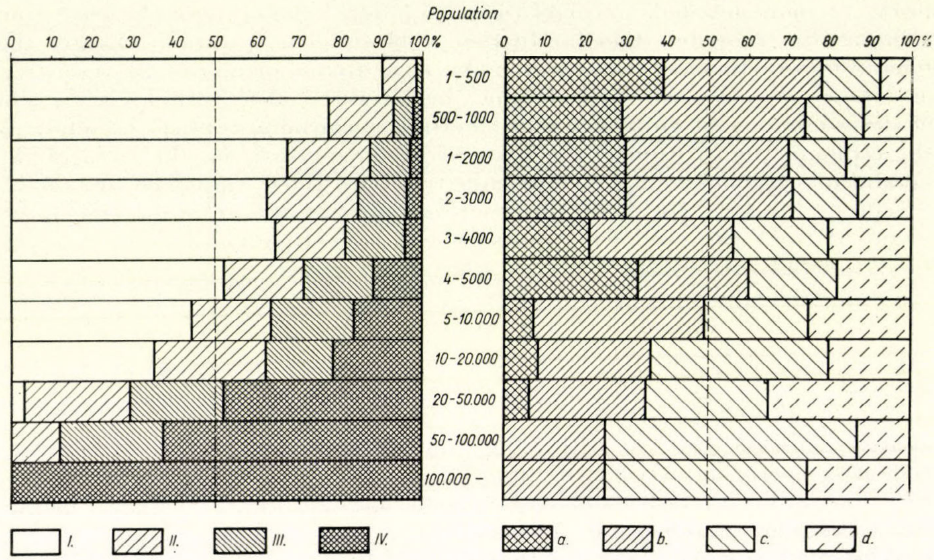


FIG. 5. Distribution of the types of settlements according to the size categories of the population, 1960

I = agrarian type; II = mixed type; III = mainly non-agrarian; IV = markedly non-agrarian type. — a = markedly industrialized (I : 0 = > 2); b = fairly well industrialized (I : 0 = 1—2); c = characterized by "other" branches (I : 0 = 1—0.66); d = markedly characterized by "other" branches (I : 0 = < 0.66)

TABLE IV

Types of the Hungarian villages and towns in terms of the occupational structure of

	Total Hungary						Transdanubia			
	villages		towns		all the settlements		villages		towns	
	number	population	number	population	number	population	number	population	number	population
1. Agrarian	71.0	57.3	5.0	1.6	69.7	35.2	75.0	56.4	—	—
2. Mixed	17.0	20.6	19.0	8.3	17.0	15.7	16.3	22.1	—	—
3. Mainly non-agrarian	8.8	14.1	19.0	10.3	9.1	12.6	7.1	16.6	8.4	4.2
4. Markedly non-agrarian	3.2	8.0	57.0	79.8	4.2	36.5	1.6	4.9	91.6	95.8
5. Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The initial stage of urbanization is represented by the settlements of *mixed character*. One-fifth of the inhabitants of the Hungarian villages live in mixed-type (II) settlements. 12 of the market-towns in the Great Plain also belong to this category, their population accounting for $8^0/_0$ of the townspeople of the country. Of the 1.5 million inhabitants of the mixed-type settlements, 1.24 million are village-dwellers and only 328,000 are townspeople.

In the *mainly non-agrarian* types (III) the agricultural population now accounts for $15^0/_0$ to $36^0/_0$. $12.6^0/_0$ of Hungary's population live in them. The population of the villages exceeds that of the towns in this category, too, being twice as large, precisely 850,000 inhabitants.

The *markedly non-agrarian* types (IV) include the highly developed cities and towns and urbanized villages. $36.5^0/_0$ of Hungary's population live in them; hence, this is the most populous category, exceeding in proportion even the settlements of the agrarian character. The concentration of people in towns greatly exceeds that in the urbanized villages: nearly half a million live in urbanized villages and 3.16 million in towns.

As to areal distribution, the transition settlements exhibit particular features owing to their varied regional functions and interconnections. (Fig. 6) Three groups can be distinguished: (1) settlements attached to industrial agglomerations; (2) settlements arranged in belts along the arterial communication lines; (3) isolated settlements in the agrarian areas.

(1) Of industrial agglomerations two different types have been developed in Hungary: (a) single-centred agglomerations associated with big industrial cities; (b) multi-centred agglomerations (conurbations) associated with minor or medium working place centres in the mining regions.

(a) In the single-centred agglomerations the working place centre is formed by the factories situated in the area of the town. The majority of the industrial employees, living in the town and in the dwelling-localities surrounding it, work in these factories. The centre of daily commuting is, at the same time,

their inhabitants, 1960

		North						Great Plain					
all the settlements		villages		towns		all the settlements		villages		towns		all the settlements	
number	population	number	population	number	population	number	population	number	population	number	population	number	population
74.0	41.8	52.5	39.8	—	—	51.8	29.7	75.6	64.3	32.5	10.3	73.5	48.5
16.2	16.4	26.6	27.8	—	—	26.2	20.9	11.4	16.8	32.5	41.4	12.3	20.8
7.1	13.5	15.4	20.7	11.0	8.6	15.3	17.6	8.1	9.8	21.6	31.1	8.9	16.0
2.7	28.3	5.5	11.7	89.0	91.4	6.7	31.8	4.9	9.1	13.4	17.2	5.3	14.7
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

that part of the agglomeration which is the best developed in central functions, The town attracts the inhabitants of the surrounding localities to its working places and central functions, and gradually becomes more and more closely united with them by means of regular commuting.

Agglomerations with great numbers of dwelling-localities are Budapest, Győr and Miskolc. In these agglomerations the focus of daily commuting is the city-centre.

The *Budapest Agglomeration* is distinguished as an independent part of the country. The inner dwelling-belt immediately surrounding the capital, together with the outer belt, has a total of 137 localities. More than 50% of the population of the inner dwelling-belt commute daily to work in the capital. The villages located in this belt are almost entirely urbanized. The outer dwelling-belt, including mainly villages of the mixed type, branches off the main railway lines well into the area of the Great Plain. The Budapest agglomeration has already begun this process in the northern half of the Danube—Tisza Midregion.

The *Győr agglomeration* unites 36 localities which form a close functional entity with the city. Here the dwelling-localities of the mixed type slightly exceed in number the localities belonging to the higher stage of urbanization. Agriculture still plays an important role in the fertile area of the dwelling-belt, where 30 to 50% of the population of the villages are either collective farmers or employees of highly developed big state farms.

The *Miskolc agglomeration* is characterized by a declining agrarian character. Out of the 38 dwelling-localities associated with Miskolc, mixed type ones occur only in the zones penetrating outward into the Great Plain. The dwelling-belt of the agglomeration mostly consists of well-industrialized localities. The fragmented pattern of the settlement network in the hill regions, where localities with less than 1,000 inhabitants predominate, and the poor quality of soils, were alike responsible for the quick absorption of the former agricultural workers by industry, as J. Major pointed out in his study on the settlement network of Hungary. On the other hand, the villages of the mixed type are rather populous and have vast agricultural areas on the northern fringes of the Great Plain.

(b) *Multi-centred agglomerations* (conurbations). The agglomeration structure of the mining regions of the Hungarian Central Mountains (the industrial districts in the Central and Northern Transdanubia, in Nógrád and in the Sajó Valley and Ózd) is different from that of the single-centred agglomerations, in that it gave rise to working place centres directly at the spots of exploitation of raw materials. These foci of industrial commuting, which lie not too far from the former urban centres, have absorbed the inhabitants of the neighbouring villages. With disintegration of several centres, these agglomerations have developed small- and medium foci of commuting, and are situated at short distances one from another. The dwelling-localities and the old settlements which were skilled more in urban functions than in industry, supply the working places with labour.

Recently, some rapidly industrialized centres of commuting have been given the status of towns, owing to a sudden increase of their population by concentration (Ajka, Várpalota, Oroszlány, Kazincbarcika, etc.). Each

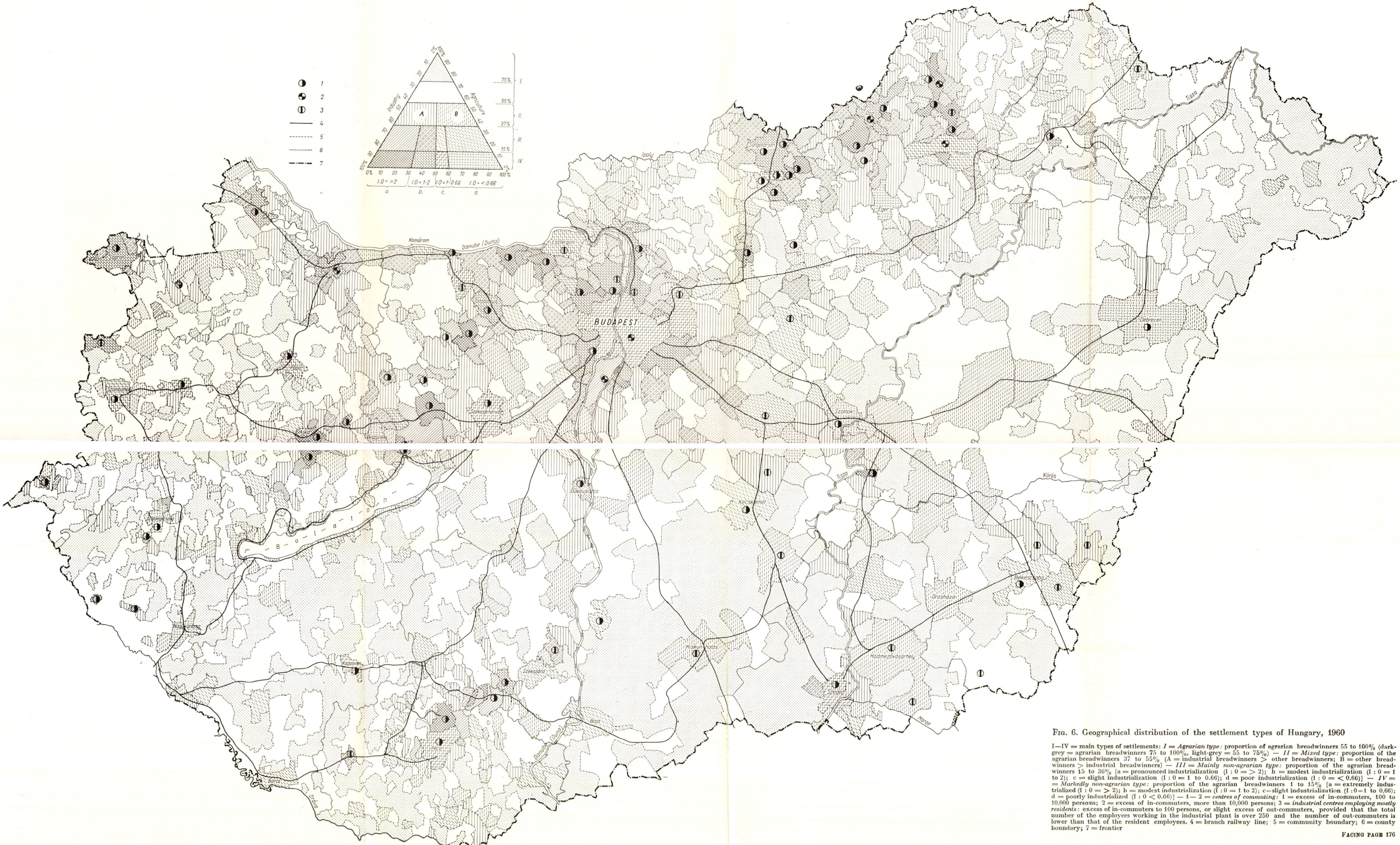


FIG. 6. Geographical distribution of the settlement types of Hungary, 1960

I—IV = main types of settlements: *I = Agrarian type:* proportion of agrarian breadwinners 55 to 100% (dark-grey = agrarian breadwinners 75 to 100%, light-grey = 55 to 75%) — *II = Mixed type:* proportion of the agrarian breadwinners 37 to 55% (A = industrial breadwinners > other breadwinners; B = other breadwinners > industrial breadwinners) — *III = Mainly non-agrarian type:* proportion of the agrarian breadwinners 15 to 36% [a = pronounced industrialization (I : 0 = > 2); b = modest industrialization (I : 0 = 1 to 2); c = slight industrialization (I : 0 = 1 to 0.66); d = poor industrialization (I : 0 = < 0.66)] — *IV = Markedly non-agrarian type:* proportion of the agrarian breadwinners 1 to 15% [a = extremely industrialized (I : 0 = > 2); b = modest industrialization (I : 0 = 1 to 2); c = slight industrialization (I : 0 = 1 to 0,66); d = poorly industrialized (I : 0 < 0.66)] — 1— 2 = *centres of commuting:* 1 = excess of in-commuters, 100 to 10,000 persons; 2 = excess of in-commuters, more than 10,000 persons; 3 = *industrial centres employing mostly residents:* excess of in-commuters to 100 persons, or slight excess of out-commuters, provided that the total number of the employees working in the industrial plant is over 250 and the number of out-commuters is lower than that of the resident employees. 4 = branch railway line; 5 = community boundary; 6 = county boundary; 7 = frontier

of them are poor in establishments of central functioning. Their population is markedly industrialized, 60 to 90% of the breadwinners are working in industry.

The urban centres of the old historical towns, though situated not far 'rom the foci of commuting, are for the most part poorly industrialized, because of their rather unfavourable communications. They are distinguished by a great number of central establishments, in contrast to the foci of commuting.

Accordingly, not only the work- and dwelling-places are differentiated in these agglomerations, owing to the transformation of the relations among the settlements, but also a new division as to the central functions is taking shape. In this respect, the present phase is characterized by an intensive polarization.

(2) The bulk of the industrial agglomerations occupy the northern one-third of the country. From this continuous zone of urban settlements, some narrow offshoots along the arterial communication lines penetrate deep into the agricultural regions. The major junctions on the main railway lines have become dwelling centres of commuting railwaymen (Szolnok, Szajol, Szombathely, etc.).

(3) The centres of micro- and meso-regions which are mostly poorly industrialized are scattered throughout the country. They may be added to the group of urban settlements discussed above. In the Great Plain they are numerous but poorly urbanized, and the agrarian breadwinners form considerable masses within their population. This is due to the peculiarities of the settlement pattern of the Great Plain and to its underdeveloped industry. As has already been stated, the future industrialization of the Great Plain will require no industrial agglomerations. It will only further the development of the existing town network. Urbanization will thus proceed by a progressive regrouping of the residents into the non-agrarian branches. So in time the agrarian and mixed-type settlements of today may increase the group of the urbanized localities.

By differentiation of the settlement types according to the occupational structure of inhabitants, the areal distribution of the non-agrarian dwelling and working places, as well as the areal patterns of the agglomerations, has become distinct. The investigations have shown that the transition localities play a very important role in the present phase of urbanization. Being integral parts of the towns — that is, components of agglomerations — they deserve to be duly considered in the plans of town-development and in egional planning.

Bibliography

Bobek, H., Hammer, A., Ofner, R. (1955) Beiträge zur Ermittlung von Gemeindetypen *Österreichische Gesellschaft zur Förderung von Landesforschung und Landesplanung*, Klagenfurt, 87

Borsos, J. (1961) Vidéki városaink (The provincial towns of Hungary), Közgazd. és Jogi Kiadó, Budapest, 442

Brüning, K. (1953) Raum und Wirtschaft. *Forschungs- und Sitzungsberichte der Akademie für Raumforschung und Landesplanung*, Bd. III, 1952, Bremen-Horn, 282

Erdei, F. (1941) Magyar falu (The Hungarian villages), Athenaeum, Budapest, 243

Fehre, H. (1961) Die Gemeindetypen nach der Erwerbsstruktur der Wohnbevölkerung. Raumforschung und Raumordnung, Köln—Berlin, 19. Jahrg. H. 3, 138—47

Lettrich, E. (1962) Az ipari települések területkomplexumai Magyarországon (Complexes of industrial settlements in Hungary), *FÉ*, vol. XI, 85—109

Major, J. (1962) Magyarország településhálózata, különös tekintettel a mezőgazdasági jellegű településekre (The settlement network of Hungary with special regard to the settlements of agricultural character), in *Mezőgazdaság és településtervezés*, Műszaki Kiadó, Budapest, 5—83

THE DISTRIBUTION OF THE MANUFACTURING AND MINING INDUSTRY OF HUNGARY

by IMRE BENCZE

Distribution and location

In recent years several economic geographers (Markos, Kóródi, Lettrich, Bora) have studied the industrial regions of Hungary, but their attempt to delimit them have led to contradictory conclusions because of the different methods of approach. In determining the regions, these authors usually took the number of the employees as a basic criterion, supplementing it with the data on migration, production co-operation, long-term plans, etc. At the same time they were emphatic in concluding that no complex industrial districts of closed production cycle could be formed in Hungary, owing to her peculiar historico-economic development. Apart from the Central Industrial Region, which is complex, the others named are characterized by one main industrial branch, the plants of which are connected by simple geographical juxtaposition rather than by productional interrelation.

This strikingly disproportionate areal view of the economic geography of Hungary is characterized by three circumstances:

(1) By 1959 Budapest concentrated 18.4% of Hungary's population, i.e. 45.2% of Hungary's industrial employees.
(2) Nine-tenths of the Hungarian manufacturing industry has been developed in the central, western and northern economic areas (including Budapest), whereas scarcely one-tenth of the industrial labour is employed in the eastern, lowland regions.
(3) Of the 3,300 administrative units in the country, 106 are settlements having more than 1,000 industrial employees each.

Since the boundaries of the industrial regions cannot be exactly stated unless a number of theoretical, methodological, etc. problems are settled, we needed, first of all, a thorough and multilateral analysis of the industrial plants and the related settlements. Therefore in our essay a detailed examination has been made of the 106 settlements in which the manufacturing industry employed more than 1,000 workers and produced a gross value above 0.02 thousand million Forints yearly.

The industrial character of the 106 settlements was determined by means of two main indices and a few supplementary ones. The first main index is: the number of industrial labourers working in the settlement; the second: the production value per employee, i.e. the stage of development of the industrial production. By these indices, the distribution of labour and the values produced — in other words, their concentration according to the settlements — are indicated. Of the supplementary indices, the number of the employees per 1,000 inhabitants indicates the degree of industrialization

TABLE I

Industrial settlements

	Mining %	Iron, steel and metal production (%)	Engineering and metal-working (%)	Precision engineering (%)	Building material industry (%)	Chemical industry (%)	Electric power production (%)
	1	2	3	4	5	6	7
					I. Complex and strikingly		
1. *Budapest*	0	5	35	8	4	6	2
					II. Highly developed		
2. Miskolc	11	40	30	—	5	1	4
3. Győr	—	4	39	3	1	2	5
4. Pécs	66	—	3	1	8	3	5
5. Szeged	—	1	2	3	3	1	4
6. Tatabánya	73	4	3	—	11	1	6
7. Debrecen	—	—	30	5	6	5	5
8. Ózd	—	91	—	—	—	—	8
9. Salgótarján	18	32	4	16	24	—	3
10. Dunaújváros	—	54	—	—	8	11	8
11. Komló	89	—	—	—	4	—	3
12. Szombathely	—	—	28	—	5	1	7
13. Sopron	—	—	4	12	7	2	—
14. Szolnok	13	—	34	—	2	4	8
15. Kaposvár	—	—	6	3	10	1	7
16. Békéscsaba	—	—	3	3	28	—	7
					III. Moderately developed		
17. Kecskemét	—	—	13	13	3	1	—
18. Várpalota	60	15	—	—	—	7	16
19. Oroszlány	90	—	—	—	—	—	—
20. Szigethalom	—	—	100	—	—	—	—
21. Székesfehérvár	1	19	16	8	4	1	10
22. Vác	—	2	33	—	3	11	—
23. Lőrinci	48	—	—	—	7	—	26
24. Pápa	—	—	22	—	6	—	—
25. Dorog	70	3	1	—	7	10	7
26. Nagykanizsa	41	—	24	2	12	—	—
27. Kazincbarcika	45	—	—	—	—	27	28
28. Ajka	31	38	—	—	16	—	12
					IV. Industrial		
29. Hódmezővásárhely	—	—	7	16	12	2	—
30. Mosonmagyaróvár	—	24	35	—	—	—	—
31. Nagybátony	99	—	—	—	—	—	—
32. Tokod	72	—	—	—	24	—	—
33. Zalaegerszeg	—	—	3	—	18	16	—
34. Baja	—	—	12	2	9	3	10
35. Martfű	—	—	—	—	3	—	—

of Hungary

Textiles (%)	Leather-processing, shoemaking, fur-dressing (%)	Wood-working, paper manufacture, printing (%)	Food industry (%)	Miscellaneous industries (%)	Total (%)	Number of industrial employees (in thousands)	Number of industrial employees per 1000 inhabitants	Ratio of the in-commuters to the number of the resident employees
8	9	10	11	12	13	14	15	16
developed industrial centre								
18	3	7	8	3	100	442.9	248	19.4
industrial centres								
2	—	2	4	1	100	42.2	295	34.1
35	—	2	9	—	100	26.0	247	38.7
3	2	1	7	1	100	24.7	215	18.4
42	6	13	22	3	100	20.3	205	18.3
—	—	—	2	—	100	18.4	353	29.0
14	4	10	19	2	100	15.8	122	10.0
—	—	—	1	—	100	13.2	387	41.7
—	—	—	3	—	100	11.7	369	40.0
14	—	1	2	2	100	10.3	332	37.5
—	2	—	2	—	100	9.4	379	42.6
16	28	5	7	3	100	9.4	172	20.7
63	—	5	7	—	100	9.2	223	19.7
2	—	12	25	—	100	9.2	201	33.5
35	—	3	33	2	100	8.2	189	26.4
34	—	4	13	8	100	8.0	162	11.2
industrial centres								
1	2	2	62	3	100	7.7	114	10.1
—	—	—	1	—	100	7.3	341	45.0
—	—	—	1	—	100	—	—	53.1
—	—	—	—	—	100	6.0	2135	92.6
17	2	3	19	—	100	5.8	103	22.1
43	—	—	7	1	100	5.7	231	27.1
—	—	—	19	—	100	5.6	501	51.3
62	—	—	10	—	100	5.6	219	17.7
—	—	—	2	—	100	5.5	548	55.0
—	—	3	15	3	100	5.3	154	13.6
—	—	—	—	—	100	5.3	346	51.0
—	—	—	2	1	100	5.1	329	53.5
foci								
41	4	1	15	2	100	4.5	84	7.9
33	—	—	4	4	100	4.4	210	21.7
—	—	—	1	—	100	4.7	620	62.6
—	—	4	—	—	100	4.2	555	52.2
47	—	4	9	3	100	4.1	173	39.0
52	—	7	5	—	100	4.0	133	6.7
—	97	—	—	—	100	4.0	1200	62.0

	Mining %	Iron, steel and metal production (%)	Engineering and metal-working (%)	Precision engineering (%)	Building material industry (%)	Chemical industry (%)	Electric power production (%)
	1	2	3	4	5	6	7
36. Eger	—	—	20	8	11	2	22
37. Hatvan	—	—	—	—	3	—	—
38. Szerencs	—	—	3	—	—	—	—
39. Nagykőrös ...	—	—	—	—	—	—	16
40. Dunakeszi ...	—	—	72	—	—	—	—
41. Borsodnádasd	24	76	—	—	—	—	—
42. Nyíregyháza .	—	—	10	5	3	2	24
43. Csolnok	100	—	—	—	—	—	—

V. Minor

	Mining %	Iron, steel and metal production (%)	Engineering and metal-working (%)	Precision engineering (%)	Building material industry (%)	Chemical industry (%)	Electric power production (%)
44. Kisterenye ...	97	—	—	—	3	—	—
45. Ormosbánya .	100	—	—	—	—	—	—
46. Gyöngyös ...	37	—	33	—	7	—	—
47. Almásfüzitő .	—	69	—	—	—	31	—
48. Zagyvaróna ..	83	17	—	—	—	—	—
49. Balinka	100	—	—	—	—	—	—
50. Esztergom ...	—	—	38	21	—	9	22
51. Kalocsa......	—	—	—	8	4	1	—
52. Nyergesújfalu	—	—	—	—	46	54	—
53. Cegléd	—	—	44	—	3	—	—
54. Lábatlan.....	—	—	—	—	92	—	—
55. Veszprém	8	—	19	—	—	—	25
56. Pusztavám ..	100	—	—	—	—	—	—
57. Farkaslyuk...	100	—	—	—	—	—	—
58. Budakalász ..	—	—	—	—	—	—	—
59. Gödöllő	—	—	3	93	—	—	—
60. Dudar	100	—	—	—	—	—	—
61. Mucsony	100	—	—	—	—	—	—
62. Tata	—	—	—	—	27	—	—
63. Sárvár	—	—	4	—	8	—	—
64. Kiskunfélegyháza.......	—	—	65	—	—	—	—
65. Bonyhád.....	—	—	—	40	3	—	—
66. Szentgotthárd	—	—	—	37	4	—	—
67. Orosháza	—	—	—	17	11	—	—
68. Kőszeg	—	—	4	—	7	1	—
69. Gyula	—	—	—	—	8	—	—
70. Szekszárd	—	—	12	—	11	2	28
71. Mezőhegyes ..	—	—	—	—	—	—	—
72. Komárom ...	—	7	—	—	11	—	—
73. Egercsehi	100	—	—	—	—	—	—
74. Szigetvár	—	—	—	5	5	—	—
75. Köles........	100	—	—	—	—	—	—
76. Tiszapalkonya	—	—	—	—	—	—	100
77. Sajószentpéter	85	—	—	—	12	—	—
78. Pilisszentiván	100	—	—	—	—	—	—
79. Szentendre ...	42	—	25	7	—	—	—
80. Sarkad	—	—	—	—	—	—	—
81. Mohács	—	—	12	—	18	—	—
82. Hódoscsépány	100	—	—	—	—	—	—

Textiles (%)	Leather-processing, shoemaking, fur-dressing (%)	Wood-working, paper manufacture, printing (%)	Food industry (%)	Miscellaneous industries (%)	Total (%)	Number of industrial employees (in thousands)	Number of industrial employees per 1000 inhabitants	Ratio of the in-commuters to the number of the resident employees
8	9	10	11	12	13	14	15	16
—	—	4	33	—	100	3.6	102	18.0
—	—	—	97	—	100	3.6	180	31.7
—	—	—	97	—	100	3.5	445	39.1
—	—	13	71	—	100	3.4	130	2.9
—	—	—	28	—	100	3.1	219	51.7
—	—	—	—	—	100	3.1	721	61.8
11	2	—	38	5	100	3.1	54	14.8
—	—	—	—	—	100	3.0	716	65.6
industrial places								
—	—	—	—	—	100	2.7	412	75.0
—	—	—	—	—	100	2.7		
—	—	3	17	3	100	2.6	92	38.2
—	—	—	—	—	100	2.5	83	61.4
—	—	—	—	—	100	2.5	92	50.1
—	—	—	—	—	100	2.5	1299	
—	—	4	6	—	100	2.3	101	21.0
20	—	—	64	3	100	2.3	170	27.7
—	—	—	—	—	100	2.3	471	35.8
24	5	1	21	2	100	2.3	60	7.7
—	—	8	—	—	100	2.1	449	41.3
—	—	17	13	—	100	2.1	83	27.3
—	—	—	—	—	100	2.1	—	—
—	—	—	—	—	100	2.1	—	—
100	—	—	—	—	100	2.1	423	59.3
—	—	—	4	—	100	2.0	112	30.5
—	—	—	—	—	100	2.0	940	92.3
—	—	—	—	—	100	1.9	—	44.9
39	29	—	5	—	100	1.9	112	23.6
4	—	—	84	—	100	1.7	156	31.1
—	—	7	13	15	100	1.7	50	12.9
—	52	—	5	—	100	1.7	176	15.6
56	—	—	3	—	100	1.6	304	35.1
24	—	13	35	—	100	1.6	51	18.3
86	—	—	2	—	100	1.6	164	7.3
57	—	9	26	—	100	1.6	65	9.5
5	—	11	18	13	100	1.6	82	33.6
13	—	—	87	—	100	1.6	—	70.8
73	—	—	9	—	100	1.5	154	26.1
—	—	—	—	—	100	1.5	—	59.9
—	40	—	50	—	100	1.5	199	12.3
—	—	—	—	—	100	1.5	—	—
—	—	—	—	—	100	1.4	598	70.7
—	—	—	3	—	100	1.4	128	25,8
—	—	—	—	—	100	1.4	479	68.2
—	—	20	6	—	100	1.4	137	32.5
10	—	—	90	—	100	1.4	113	5.1
23	—	37	10	—	100	1.4	77	8.5
—	—	—	—	—	100	1.4	350	—

	Mining %	Iron, steel and metal production (%)	Engineering and metal-working (%)	Precision engineering (%)	Building material industry (%)	Chemical industry (%)	Electric power production (%)
	1	2	3	4	5	6	7
83. Mátranovák .	100	—	—	—	—	—	—
84. Hidas	94	—	—	—	6	—	—
85. Putnok	84	—	—	—	10	—	—
86. Edelény	100	—	—	—	—	—	—
87. Bázakerettye	99	—	—	—	—	—	—
88. Sátoraljaújhely	—	—	—	2	9	—	—
89. Nagyatád ...	—	—	—	—	4	—	—
90. Lovászi	100	—	—	—	—	—	—
91. Herend	55	—	—	—	45	—	—
92. Sajókaza	100	—	—	—	—	—	—
93. Diósd	2	—	98	—	—	—	—
94. Keszthely ...	—	—	—	—	25	—	45
95. Kurittyán....	100	—	—	—	—	—	—
96. Rudabánya ..	98	—	—	—	—	—	—
97. Makó	—	—	41	—	12	—	—
98. Dombóvár ...	—	—	—	6	39	1	—
99. Ercsi	—	—	—	—	—	—	—
100. Simontornya .	—	—	—	—	—	—	—
101. Paks	—	—	—	—	10	—	—
102. Padrag	100	—	—	—	—	—	—
103. Ács	—	—	—	—	—	—	—
104. Sárisáp	100	—	—	—	—	—	—
105. Király	100	—	—	—	—	—	—
106. Berhida......	—	—	—	—	—	100	—

of the settlement. The ratio of the daily commuters to resident employees indicates the force of attraction of the industrial community on its environment.

By way of the above system of indices the industrial settlements have been classified into five groups (Table I). For each settlement we indicate: the sectional structure of 12 branches of the manufacturing industry in terms of employees; the number of the employees; the gross value of the products; the annual average production value per employee; the number of industrial employees per 1,000 inhabitants; and the ratio of the commuters to total employees.

Grouping of the industrial settlements in the order of magnitude

It follows from the particular economico-geographical conditions of Hungary that her capital city, Budapest, represents a *complex and strikingly developed industrial centre* (I). The category of the other *highly developed centres* (II) includes settlements with more than 8,000 labourers and a production value above 0.80 thousand million Forints yearly. An additional criterion is that, as a rule, more than 200 per 1,000 inhabitants of a settlement are industrial employees.

Textiles (%)	Leather-processing, shoemaking, fur-dressing (%)	Wood-working, paper manufacture, printing (%)	Food industry (%)	Miscellaneous industries (%)	Total (%)	Number of industrial employees (in thousands)	Number of industrial employees per 1000 inhabitants	Ratio of the in-commuters to the number of the resident employees
8	9	10	11	12	13	14	15	16
—	—	—	—	—	100	1.3	438	18.5
—	—	—	—	—	100	1.3	467	53.5
—	—	—	6	—	100	1.3	204	31.2
—	—	—	—	—	100	1.3	193	28.9
—	—	—	1	—	100	1.3	891	73.5
28	—	12	49	—	100	1.3	79	11.4
34	—	2	60	—	100	1.3	145	4.8
—	—	—	—	—	100	1.3	1094	66.5
—	—	—	—	—	100	1.2	577	57.9
—	—	—	—	—	100	1.2	347	42.3
—	—	—	—	—	100	1.2	801	78.2
5	—	—	25	—	100	1.2	80	26.0
—	—	—	—	—	100	1.2	587	63.8
—	—	—	2	—	100	1.2	320	50.0
—	—	6	37	4	100	1.2	38	11.9
—	—	41	13	—	100	1.2	75	19.4
—	—	—	100	—	100	1.1	145	49.6
—	89	—	3	8	100	1.1	242	6.5
—	—	—	90	—	100	1.1	93	4.1
—	—	—	—	—	100	1.1	391	56.6
—	—	—	100	—	100	1.1	129	20.1
—	—	—	—	—	100	1.0	249	40.1
—	—	—	—	—	100	1.0	667	66.8
—	—	—	—	—	100	1.0	202	31.9

The *moderately developed industrial centres* (III) include settlements with over 5,000 industrial employees and gross production value above 0.50 thousand million Forints yearly. In this category more than 100 per 1,000 inhabitants are industrial employees.

Almost every settlement in the three above-mentioned groups performs central functions in the regional organization of industrial production. As regards this function, Budapest leads and influences the whole country; in category II it usually comprises an economic region while in category III it covers minor economic or administrative units (mesoregion, municipal district).

The *industrial foci* (IV) employ over 3,000 labourers; their annual production value exceeds 0.25 thousand million Fts in most of the settlements. The industrial foci, as a rule, have 2 or 3 main industrial activities, although some settlements (mainly county seats such as Hódmezővásárhely, Eger, Nyíregyháza) are remarkable for their multisectoral pattern. In a few settlements the proportion of commuters is markedly high.

The *minor industrial places* (V) number about 60% of the industrial settlements and on the average employ more than 1,000 labourers each; and each produces values over 0.02 thousand million Forints yearly. They are highly specialized. In 32 of the 63 settlements production is conducted in one industrial branch, and in 11 settlements the proportion of single leading branches exceeds 60%. In most of the settlements mining or the food processing industry predominates; the settlements belonging to this category account for 30.5% of the miners and 13.9% of the employees of the food industry. The number of commuters — rather high in the mining regions—exceeds 40% in about half of the settlements. Consequently, the ratio of industrial employees to every 1,000 inhabitants reaches abnormally high values, so that these indices cannot be used for determining the industrial character of the settlements.

Since in the towns it is industrial production that usually serves as the basis of economic activity, a comparison between the character of the settlements and the stage of urbanization may reveal some useful information. In category II, all 15 settlements are towns, whereas three of the settlements in category III are not large enough to be ranked as towns. In category IV the proportion of towns is only slightly higher than 50%, for 7 of the 15 industrial foci are not towns at all. Finally, as regards category V, only 17 of the 63 minor industrial working places are towns. The uneven industrial development of these towns can be easily recognized, if we consider that 2 of the 17 towns (Veszprém, Szekszárd) are county seats, while 13 of them are administrative centres of municipal districts. On account of the town status and the central functions of the 15 settlements, they ought to be at least industrial foci or moderately developed industrial centres.

The industrial function of many Hungarian towns is insignificant; 13 of the 63 towns are so low in industrial production as not to satisfy the criteria of an industrial settlement.

The distribution of the 106 industrial settlements by categories, and the percentage ratios of the individual categories to the total of employees in each particular industrial branch, are shown in Table II.

It can be seen from this table that the 106 settlements comprise 91.8% of the total employees engaged in Hungary's manufacturing industry. Their share of the main sectors (iron, steel and metal production, mechanical and precision engineering, textile industry) is above 95%. Somewhat smaller is the percentage in mining and the food industry. About $^1/_3$ of the employees of the building material industry are working in settlements, mainly brickworks, quarries, gravel pits, etc., where the number of industrial labourers is less than 1,000.

The high degree of concentration of Hungary's manufacturing industry is evidenced by the fact that Budapest, together with the 15 highly developed industrial centres, employs more than 80% of the workers in the iron, steel and metal production, mechanical and precision engineering, wood-working, paper manufacture, printing and other industries, and just short of 80% of the employees of the textile industry. The minor industrial settlements participate chiefly in extractive industry or in basic material production.

After examination of the sectoral structure of the above 106 industrial settlements we may draw the following general conclusions:

(1) Industrial settlements having many or several industrial branches are relatively few, and the industry of most settlements is highly specialized.

(2) The settlements with two or more industrial branches are characterized, as a rule, by a combination or juxtaposition of branches belonging either

TABLE II

Percentage ratios of the industrial settlement categories to the total number of the employees of Hungary's individual industrial branches, 1959

	Number of industrial settlements	Mining	Iron, steel and metal production	Engineering and metal-working	Precision engineering	Building material industry	Chemical industry	Electric power production	Textiles	Leather-processing, shoemaking and fur-dressing	Wood-working, paper manufacture, printing	Food industry	Other industries	Total
I. Complex and strikingly developed industrial centre	1	0.2	31.3	70.5	72.3	24.3	31.8	26.3	54.9	46.0	64.9	31.8	70.1	45.2
II. Highly developed industrial centres	15	34.1	54.3	12.6	12.0	20.3	18.5	30.7	22.8	18.5	17.2	18.5	11.1	22.3
III. Moderately developed industrial centres	12	17.5	5.9	6.4	4.0	8.7	9.1	17.7	8.1	1.0	2.3	9.1	5.7	8.6
IV. Industrial foci	15	8.7	4.6	2.3	2.4	4.5	12.0	5.0	3.8	14.9	3.1	12.0	2.5	5.4
V. Minor industrial places	63	30.5	3.1	3.2	9.1	10.6	13.9	9.4	7.0	11.3	6.4	13.9	7.9	10.3
Total	106	91.0	99.2	95.0	99.8	68.4	85.3	89.1	96.6	91.7	93.9	85.3	97.3	91.8

to the heavy industry or to the light and food industries. Consequently, in some settlements it is male labour, while in others it is female labour, that is related to the problem of employment.

(3) As a rule, one particular industrial branch occupies 50 to 60% of all industrial workers, even in those relatively populous central settlements (categories II, III, IV) where industry is being conducted in a multisectoral structure. In other words, the manufacturing industry of a settlement like these centres is regarded as specialized, despite its multisectoral structure.

Of the 106 Hungarian settlements ranked as industrial, 40 have an unisectoral structure, 16 are bisectoral, and 16 are trisectoral.*

Of the 40 unisectoral industrial settlements, 25 are mining localities, 6 constitute centres of the food industry, and 3 are centres of mechanical or precision engineering.

In most of the bi- or trisectoral settlements mining or food-industry represents the basic industrial branch. The first is commonly associated with other branches of heavy industry, while the second relates to other branches of light industry. There are relatively few settlements where heavy and light industries are proportionally coupled.

If we attempt to assess the degree of complexity by the number of the branches present, we find the industrial development of the individual settlements to be more or less directly proportional to the degree of complexity. The only settlement in Hungary in which all of the 12 chief branches are present, is the capital, Budapest. Then the order of succession is as follows (county seats are in italics):

11	branches:	*Pécs*, *Szeged*, *Székesfehérvár*
10	,,	*Miskolc*, *Debrecen*
9	,,	*Győr*, *Szombathely*, *Kaposvár*, *Kecskemét*, Hódmezővásárhely
8	,,	Dunaújváros, *Szolnok*, *Békéscsaba*, Vác, *Nyíregyháza*, *Szekszárd*
7	,,	*Tatabánya*, *Salgótarján*, Sopron, Nagykanizsa, Dorog, *Zalaegerszeg*, *Eger*, Cegléd.

It is characteristic that 18 of the 19 county seats of Hungary have a prominent multisectoral structure, which may be explained, in the last analysis, by the central functions of these towns. As a result of this, even Szekszárd, giving employment to hardly 1,500 industrial workers, becomes a multisectoral industrial settlement. It is worthy of mention that Dunaújváros, which is 15 years old, has also developed into a multisectoral settlement.

Grouping of the industrial settlements into economic regions

The grouping of the industrial settlements into economic districts shows the following pattern (Table III and Figs. 1, 2):

The *Central Industrial Region* lies in the communication and consumption focus of various regions, and in near proximity to sources of raw industrial

* The term "unisectoral" or "bisectoral" refers to settlements where the proportion of one industrial branch, or the aggregate proportion of two branches, respectively, exceeds 90%; while "trisectoral" refers to those where the aggregate proportion of three industrial branches is at least 80%.

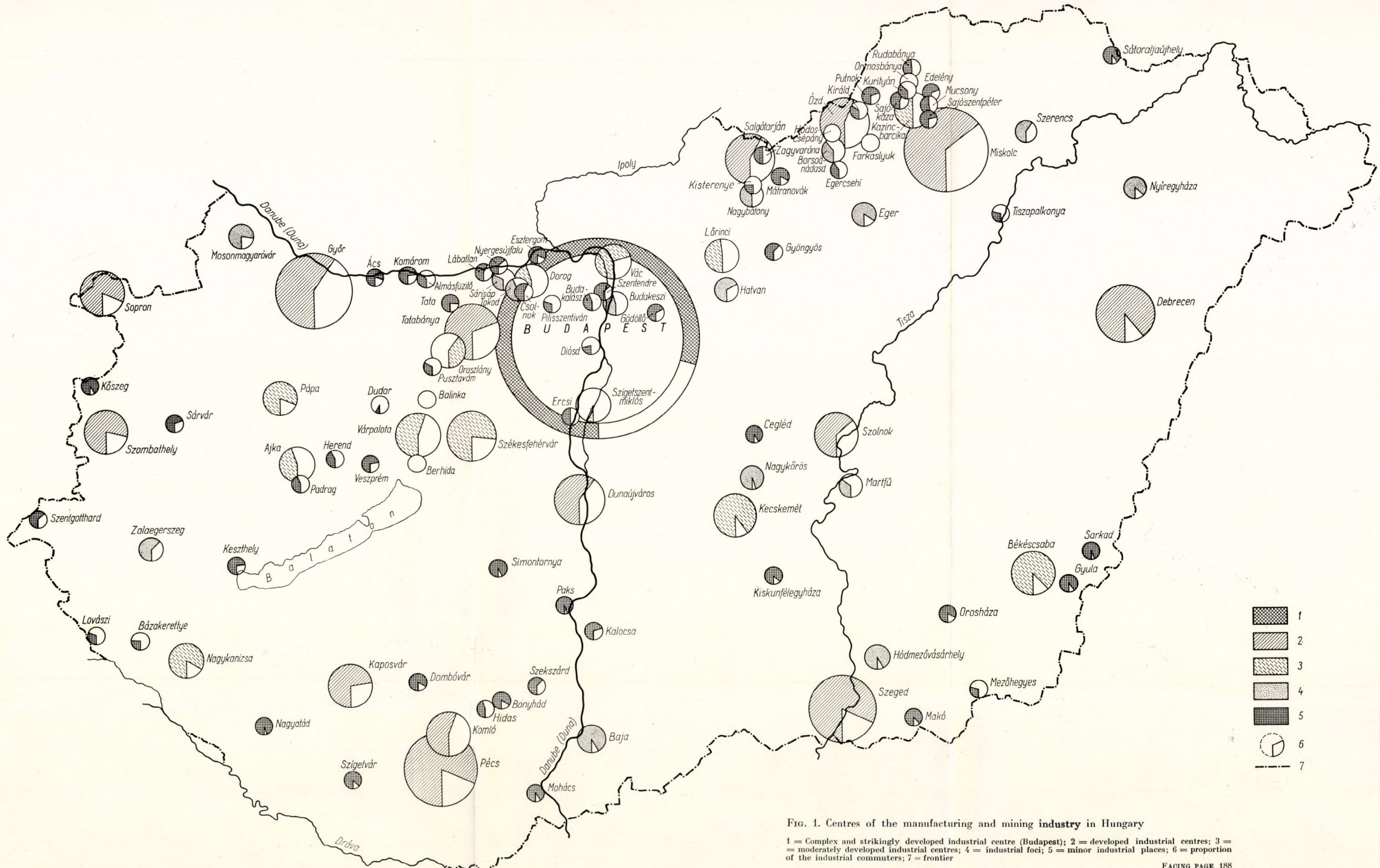


FIG. 1. Centres of the manufacturing and mining **industry** in Hungary

1 = Complex and strikingly developed industrial centre (Budapest); 2 = developed industrial centres; 3 = = moderately developed industrial centres; 4 = industrial foci; 5 = minor industrial places; 6 = proportion of the industrial commuters; 7 = frontier

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and building materials. Its industrial settlements are only $^1/_5$ of the total in Hungary but employ more than $55^0/_0$ of total industrial labour in the same categories. Striking is Budapest's approximately half-a-million industrial employees (nearly half of the total employees in all the Hungarian industrial settlements). In the rest of the industrial settlements of the Central Industrial Region, however, the number of employees per settlement averages about 3 thousand. It appears from Table III that the Central Industrial Region has a striking proportion of the processing industry (engineering, chemical, textile industries, etc.). At the same time, Budapest also maintains a highly developed basic material industry; e.g. it employs nearly one-third of the total of labour in iron, steel and metal production, although this demands the transport of immense amounts of raw materials at high freight costs. The Central Region, apart from Budapest, is characterized primarily by mining (Dorog and surroundings) and basic material production (Dunaújváros). The food industry of the Danube—Tisza Midregion (Cegléd, Nagykőrös) is also voluminous. In the immediate neighbourhood of the capital, however, the processing industry represents the main and characteristic branches.

The long-term plans will result in further development of the complex character of the Central Industrial Region. Its processing industry (engineering, chemical, light and food industries) is planned for combination with an independent power basis: a thermo-electric power plant and an oil refinery operated on petroleum piped from the Soviet Union. Also the basic material production will become augmented. Recently, the plant units of the Danube Cement and Lime Works have developed a very high productivity rate.

The problems of the manufacturing industry of Budapest are complicated and demand particular attention. Here the rapid growth of population must be checked, and the abnormal concentration of the manufacturing industry has to be progressively reduced. At the same time, we have to ensure the maximum development of national manufacturing industry with the least possible investments. The recent past has shown that this can be achieved most economically not by erecting new plants, but by reconstructing, enlarging, etc. the existing ones. This is the reason why so much stress has been placed upon the reconstruction of the existing plants of the capital, which, in turn, checked the rate of industrial development in the rest of the country. To achieve the right proportions is becoming nowadays one of the most important points of long-term planning. The industrial plants of Budapest are to be modernized by automatization, so that the labour demands of its factories may be reduced to a minimum. So the ratio of Budapest to total national products will increase in the near future, if only to a slight extent, but at the same time its demand for labour will become substantially lower than that of the country-side.

The highly developed areas of the *Northern Industrial Region* can be most clearly delimited. Its major industrial settlements are concentrated in two belts: 28 industrial settlements engage $14^0/_0$ of the industrial employees of the country. The predominance of heavy industry is well illustrated by the fact that nearly $^3/_4$ of the labourers of the 28 industrial settlements are miners, metal-workers, or workers in the engineering industry. Electric power

TABLE III

Distribution of the industrial settlements by economic regions and their percentage

	Number of industrial settlements		Mining	Iron, steel and metal production	Engineering and metal-working	Precision engineering	Building material industry	Chemical industry
I. Budapest	1	a	0.2	31.6	74.5	72.5	35.7	69.6
		b	0.2	5.3	35.1	7.9	3.7	5.8
II. Central Industrial Region (excluding Budapest)	19	a	10.7	7.9	6.5	5.1	11.8	10.1
		b	21.6	9.7	22.7	4.0	9.1	6.2
III. Northern (or Borsod) Industrial Region	28	a	33.7	48.3	6.9	5.0	13.6	5.1
		b	32.8	28.6	11.5	1.9	5.1	1.4
IV. Middle-Transdanubian Economic Region	22	a	33.2	9.1	2.0	1.2	12.4	6.5
		b	53.0	8.9	5.5	0.7	7.5	3.2
V. Southern-Transdanubian Economic Region	13	a	21.3	—	0.8	3.1	10.3	2.6
		b	45.0	—	2.8	2.6	8.3	1.7
VI. Little Plain	8	a	—	2.9	3.7	5.0	4.4	1.6
		b	—	4.3	15.1	4.8	4.0	1.2
VII. South-eastern Great Plain Economic District	11	a	—	0.2	1.7	6.1	8.8	1.0
		b	—	0.4	7.7	6.2	8.7	0.8
VIII. Middle and Northern Tisza Economic District	4	a	0.9	—	3.9	2.0	3.0	3.5
		b	3.7	—	25.6	3.0	4.4	4.1
Total:	106	a	100	100	100	100	100	100
		b	13.7	8.3	23.4	5.4	5.2	4.2

a = ratios of the individual industrial branches of the district to the total of Hungary
b = sectoral structure of the manufacturing industry of the district

production, building material industry, and food industry in the lowland fringes of the region are also important.

The industrial settlements here are characterized, first of all, by a high degree of specialization; e.g. Hatvan and Szerencs by food-processing, Tiszapalkonya by power production and Ózd by siderurgy. There are 14 exclusively mining settlements. Of three county seats (Miskolc, Salgótarján, Eger), only Eger exhibits a multisectoral pattern. In Miskolc it is metallurgy and machine production, while in Salgótarján metallurgy coupled with building material production (glass industry) that give employment to 70%, i.e. 56% of the workers of the towns. In addition, coal-mining is important at both places. The sole iron-ore mine of Hungary is in this region.

ratios to the total number of employees of Hungary's individual industrial branches, 1959

Electric power production	Textiles	Leather-processing and shoemaking	Wood-working, paper manufacture, printing	Food industry	Other industries	Industrial research institutes	Total	Centres of the economic regions
29.5	57.6	50.7	67.9	39.5	72.4	90.7	49.6	—
2.2	18.0	2.9	6.9	8.0	3.0	1.0	100	
6.8	4.7	—	2.5	6.6	1.3	—	6.8	Budapest
3.8	10.8	—	1.9	9.8	0.4	—	100	
23.8	0.9	—	3.4	13.6	3.0	—	14.0	Miskolc
6.4	0.9	—	1.2	9.8	0.4	—	100	
14.1	2.9	2.1	4.4	4.0	5.5	8.8	8.6	Székesfehér-
6.1	5.1	0.7	2.6	4.8	1.3	0.6	100	vár
9.0	4.3	12.1	4.6	8.9	3.5	—	6.4	Pécs
5.2	10.4	5.3	3.7	13.9	1.1	—	100	
5.9	17.1	10.4	3.2	6.2	2.5	0.5	5.7	Győr
3.8	46.8	5.1	2.9	11.1	0.9	0.0	100	
4.1	10.6	6.7	7.9	13.9	10.3	—	5.3	Szeged
2.9	31.5	3.6	7.6	26.6	4.0	—	100	
6.8	1.9	18.0	6.1	7.3	1.5	—	3.6	Debrecen
7.1	8.4	14.2	8.6	20.1	0.8	—	100	
100	100	100	100	100	100	100	100	100% =
3.7	15.5	2.8	5.1	10.1	2.1	0.5	100	= 892.161 employees

The long-term industrial development of the region is planned to proceed in two directions: on the one hand, the engineering industry based on the extractive and basic material industries, and the chemical industry and electric power production based on coal and imported natural gas, are to be further developed; on the other hand, the light industry (especially the textile industry) which is still underdeveloped will have to be expanded in order to provide employment for the female residents, who require work.

The energy structure of the district will also change. The gas pipe-line will be extended to Ózd, so that the Borsod Chemical Combine and the Berente Chemical Works may also be fed by natural gas. By these measures, great amounts of coal will be released for other purposes. From the point of view of long-term industrial development, it is the belt of the Tisza that may be reckoned with, as only this area is suitable for locating industrial plants of high water consumption.

The *Middle-Transdanubian Economic Region* is the richest in mineral resources (bauxite, manganese, kaolin, bentonite, fireclay, limestone) in Hungary. Accordingly, in its 22 industrial settlements more than half of the labourers are miners. Eocene brown coal is mined at Tatabánya and its environs, and lignites of good quality at Várpalota and its neighbourhood. Coal is exploited at Ajka, bauxite in its neighbourhood, while along the Yugoslav frontier oil is being producted.

Metallurgy of non-ferrous metals, namely aluminium production, will be developed here in its full verticality in the near future. The bauxite supplied from the mines is smelted into alumina at Ajka and Almásfüzítő; alumina is treated in the furnaces of Ajka, Tatabánya and Almásfüzítő, which yield aluminium ingots; the ingots are converted into rolled stock by the Székesfehérvár Light Metal Works, which was recently opened.

Electric power production is also significant in this district. The thermoelectric power stations, fueled by local energy producers (Tatabánya, Várpalota, Ajka, Oroszlány), partly fill the local needs for energy (chiefly alumina and aluminium production), and partly meet the increasing energy-demands of the Central Industrial Region.

The chemical industry of the region has two aspects. Fertilizers and dyestuffs are turned out, based on brown coal and lignite resources, at Várpalota, while at Almásfüzitő and at the neighbouring Szőny there are oil refineries for the oil piped in from south Zala.

The building material production of the district is of national importance. At Tatabánya, cement is producted, while in the Balaton Highland considerable quarry operation is carried on. The porcelain factory of Herend has a good reputation in Europe.

Light and food industries are underdeveloped as compared to the national standard.

The industrial settlements of this economic region, as a rule, show either unisectoral, or bisectoral structure. Only the three county seats (Székesfehérvár, Veszprém, Zalaegerszeg) are remarkable for their complexity. As regards Tatabánya, despite its seven branches of manufacturing industry, it is ranked among the specialized settlements, for 73% of its active inhabitants are employed in coal-mines.

Middle-Transdanubia is developing multilaterally. Its growing electric power output (Oroszlány, Ajka) will promote the development of bauxite mining, alumina production and aluminium metallurgy. The oil-refining capacity of the region also increases and so does the production of nitrogenous and phosphate fertilizers. Recently a light metal plant started to work at Székesfehérvár.

In the *South-Transdanubian Economic Region* coal-mining is the leading industrial branch, 45% of the labour of the 13 settlements are miners, and mining is the main branch in three (Pécs, Komló, Hidas) of them. The Jurassic hard coal of the Mecsek is the best quality coal in Hungary. In part, it is suitable for coking, too.

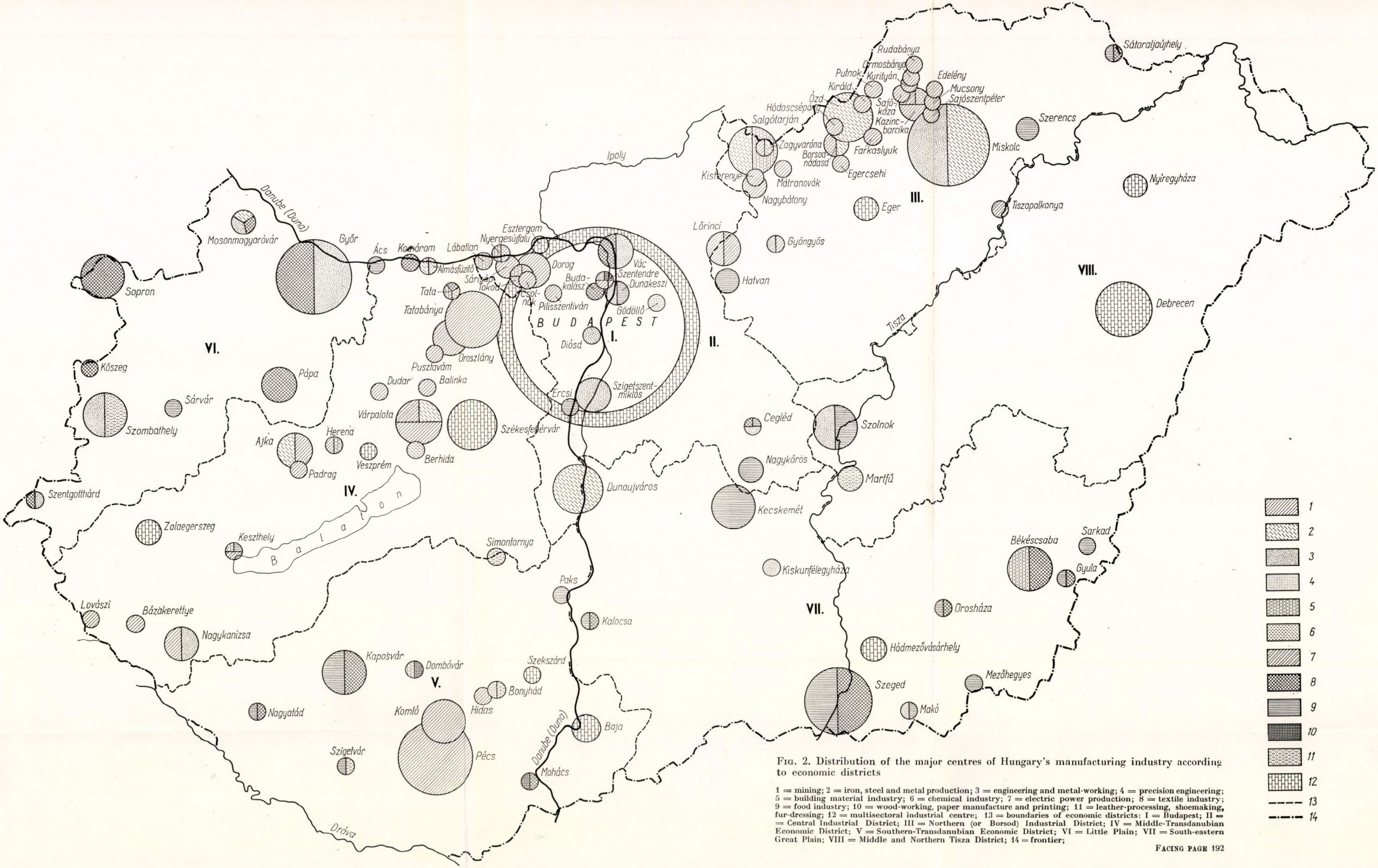

FIG. 2. Distribution of the major centres of Hungary's manufacturing industry according to economic districts

1 = mining; 2 = iron, steel and metal production; 3 = engineering and metal-working; 4 = precision engineering; 5 = building material industry; 6 = chemical industry; 7 = electric power production; 8 = textile industry; 9 = food industry; 10 = wood-working, paper manufacture and printing; 11 = leather-processing, shoemaking, fur-dressing; 12 = multisectoral industrial centre; 13 = boundaries of economic districts: I = Budapest; II = Central Industrial District; III = Northern (or Borsod) Industrial District; IV = Middle-Transdanubian Economic District; V = Southern-Transdanubian Economic District; VI = Little Plain; VII = South-eastern Great Plain; VIII = Middle and Northern Tisza District; 14 = frontier;

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In South-Transdanubia $^1/_3$ of the employees are working in the factories and workshops of light and food industries.

Of the 13 industrial settlements, only the manufacturing industries of Szekszárd and Baja show some complex features. Further industrialization of both towns is one of the objectives of long-term plans. The industrial and urban development of Pécs should be promoted by industrial processing branches.

The *Little Plain Region* is poor in mineral resources, but its agricultural raw materials are considerable. Its industry is located partly along the Danube, partly along the western frontier, and has favourable conditions for communication and transport, because the railroad and public road run parallel to the water way from Budapest up to Győr and there branch off to form a dense network in the region.

According to the long-term plans, engineering, light and food industries will be greatly amplified.

The manufacturing industry of the Little Plain region is characterized by the largest textile industry next to Budapest. There are 8 industrial settlements with over one thousand employees. Kőszeg alone accounts for more than 80%, Sopron and Pápa for more than 60%, Szentgotthárd for more than 50% and Győr and Mosonmagyaróvár for one-third of the industrial labourers of each of these town, where the cotton, wool, linen and silk industries are important. In contrast to the other centres of the textile industry, apart from Budapest, the textile industry here is characterized by an intraregional verticality of the enterprises.

Second in importance is the mechanical and precision engineering of the region, accounting for about 20% of the employees. The most important centres of the engineering industry are Győr, Szombathely, Mosonmagyaróvár and Szentgotthárd. The agricultural machinery factories formerly satisfied mainly the requirements of the Little Plain, now they are meeting nation-wide demands.

Of the other branches, the shoe industry and alumina production are important.

The five economic regions discussed so far are characterized, first of all, by a highly developed industry, though in certain regions (e.g. in the Little Plain) the level of agriculture greatly surpasses the national average. The significance of the two lowland regions (South-eastern Great Plain and Middle and Upper Tisza Region) still rests with agriculture. Their manufacture is dominated by the food industry which is closely interconnected with agricultural production; and, to a lesser degree, by the textile industry which processes local raw materials. Engineering came to importance only after the Liberation.

A favourable physical condition for long-term industrial development is supplied by the deep subsurface strata of the Great Plain, from which come Hungary's biggest supply of natural gas, the basis of production of fertilizers and synthetic materials and supplies for glass-plants. Raw materials imported mainly from the Soviet Union are allotted to these areas, but some regions situated close to the power sources of the Mecsek and the northern Mountains get the raw material from there. The steadily intensifying agriculture will supply raw products for the developing branches of the food processing industry. The belts of the Danube and the Tisza are best for intensively water consumming plants. Also, favourable transport facilities are supplied by these two navigable rivers.

The sectoral structure of the 11 industrial settlements of the *South-eastern Great Plain* clearly reflects the economy of the region. In fact, the most characteristic branch is the food industry, though textile absorbs somewhat more labour. About $^2/_3$ of the workers of the district are employed in these two branches.

Most of the engineering plants were established in the course of the first Five-Year Plan.

The manufacturing industry of all three county seats (Szeged, Kecskemét, Békéscsaba) shows some complex features, but most striking is the complexity of Hódmezővásárhely, a county seat formerly. The chief problem of the industrial settlements of the South-eastern Great Plain is the employment of male labour which is increasing from year to year. The plans for industrialization may somewhat relieve the problems of restratification.

According to the preliminary plans, Szeged will become the centre of a modern major district. Heavy-industry plants, mostly labour-intensive branches with little demand for raw and basic materials, will be located in this city, which, however, in the next decades will be developed into a centre of the chemical industry, mostly water-intensive chemical works.

The *Middle and Northern Tisza Region* is industrially the least developed in Hungary. It suffices to mention that only four settlements can be ranked as industrial. Three of them (Debrecen, Szolnok, Nyíregyháza) are county seats along the railway line Záhony—Budapest. The industrial character of the district is determined by food industry and, to a smaller extent, by engineering.

The underdevelopment of industry in the district is evidenced by the numbers of industrial employees per 1,000 inhabitants on the county scale, as low as 58 for Hajdú-Bihar and 29 for Szabolcs-Szatmár, in contrast to 219 in Komárom, 154 in Borsod, 154 in Győr-Sopron, 137 in Veszprém and 108 even in county Csongrád.

It is rather difficult to account for this marked underdevelopment. Although no energy producers (except natural gas) exist in the region, the conditions of communication, the high birth rate, the necessity of raising the standard of living demand a more uniform distribution of the manufacturing industry.

The trend of development

In 1960 the number of employees of all of Hungarian industry (state, co-operative and private) was above 1 million. According to the decision of the VIIIth Congress of the Hungarian Socialist Workers' Party, Hungary's national income is to be quadrupled by 1980; and the production of industry is to be raised by 400%. This can be achieved, of course, by increasing productivity, but the number of the industrial employees will also be doubled by that time, i.e. about 1 million more labourers will have to be given employment. This large-scale development will considerably change the areal distribution and specialization of the regions and their settlements. Most of the industrial settlements will lose their specialized character and develop in the direction of complexity.

Hungary's industrial settlements (chiefly the minor ones) have been built, as a rule, on existing raw material and fuel bases. Since no fundamental changes are to be expected in the geological exploration of Hungary, the long-term industrial planning has to reckon with the actual labour market (labour released from agriculture), the possibilities for water production, the conditions of communication and transport.

Efficiency requires that the long-term plans should bring production nearer both to the raw-mineral resources and to the market; and that the industry of the areas should be specialized by regional concentration. At the same time, the economic planners must aim at a complex development, so that reasonable co-operation in production should result.

In conclusion, the industrial settlements of Hungary have to be developed according to the following fundamental principles:

(1) The industrial preponderance of Budapest must be progressively abated. (2) Development must be focused on the manufacturing industry of potential antipoles of Budapest (Miskolc, Debrecen, Szeged, Pécs, Győr). (3) For the sake of a feasible concentration of investments, a reasonable development of the industrial settlements with more than 3,000 employees (highly and moderately developed centres) must be effectuated. (4) Industrial enterprises have to be located in the settlements ranked as agricultural towns in the Great Plain areas of the country (market- and Hajdú-towns),* in order to achieve a more even distribution of industry.

* Six towns of Hajdú-Bihar county where the "Hajdú" warriors settled down in the 17th century.

AJKA—THE BAUXITE AND ALUMINIUM TOWN OF HUNGARY

(OUTLINE OF ECONOMIC GEOGRAPHY, SETTLEMENT AND POPULATION)

by GYÖRGY MARKOS

Ajka—Hungary's youngest town, acquired a town status in 1959.

A hundred years ago it was one of those small villages occurring by the score in the Bakony Mts. Its population, subsisting on a meagre agriculture, did not possess much of the land, as it mostly belonged to the latifundia owned by the bishop of Veszprém, the counts Zichy and other large landowning families.

Eighty years ago, the railway line linking Budapest—Szombathely—Grác reached Ajka village. About the same time, brown coal deposits were discovered in the outskirts of the village. Soon Austrian capital was invested, and the extraction of coal began.

Thirty years ago, a bauxite deposit of the best quality, and the largest in Europe, was discovered in the environs of Ajka.

Twenty years ago the construction of a combine consisting of alumina works, an aluminium furnace and a thermo-electric power plant was begun.

Ten years ago a rapid development of production started which resulted in Ajka becoming a town both *de facto* and *de jure*. Ajka is now the centre of an area with a radius of 15 to 20 km — a new industrial district grown around coal, bauxite and manganese ore mines: with an electric power station, aluminium furnace, glass works, coal separator, food and telecommunication workshop in the town. So quite an aggregation, based on mineral raw materials, power resources and processing plants has come into being within such a small area that it is unmatched the world over.

The geographical situation of Ajka is physiographically determined by the fact that it lies in the centre of Transdanubia and along a tectonic fracture of roughly east-west direction, crossing the Bakony Mts, north of Lake Balaton. Administratively, the Ajka area is extended to include the Devecser District of County Veszprém and a few villages of the neighbouring districts. Apart from the town of Ajka (with 15,000 inhabitants in 1960 and 18,000 in 1963), it comprises 50 localities with a total of 74,000 inhabitants and covers about 925 km^2 (Fig. 1).

Determinative elements of its physiographical environment are the geology and morphogenesis of the Bakony Mts. The mountain range is mostly made up of Triassic limestones and dolomites resting on an ancient crystalline basement, but considerable masses of Jurassic and Cretaceous rocks can also be found in the area. The coal seams were formed on the Triassic bottom of the lagoons of the Upper Cretaceous. The actually known bauxite deposits, —numerous lenticular bodies of various sizes—(Szőc, Halimba, Nyírád) were laid down in Triassic and partly Liassic sink-holes under the tropical-subtropical climate of the Lower and partly Upper Cretaceous. The manganese ore deposits, lying at a distance of only 8 km from Ajka (Úrkút), are supposed by some specialists to have been formed in the Middle Liassic, while others favour the Upper Liassic.

The surface of the area sank and rose repeatedly in the Mesozoic and Tertiary, and meanwhile it was intensively faulted. Like Hungary in general,

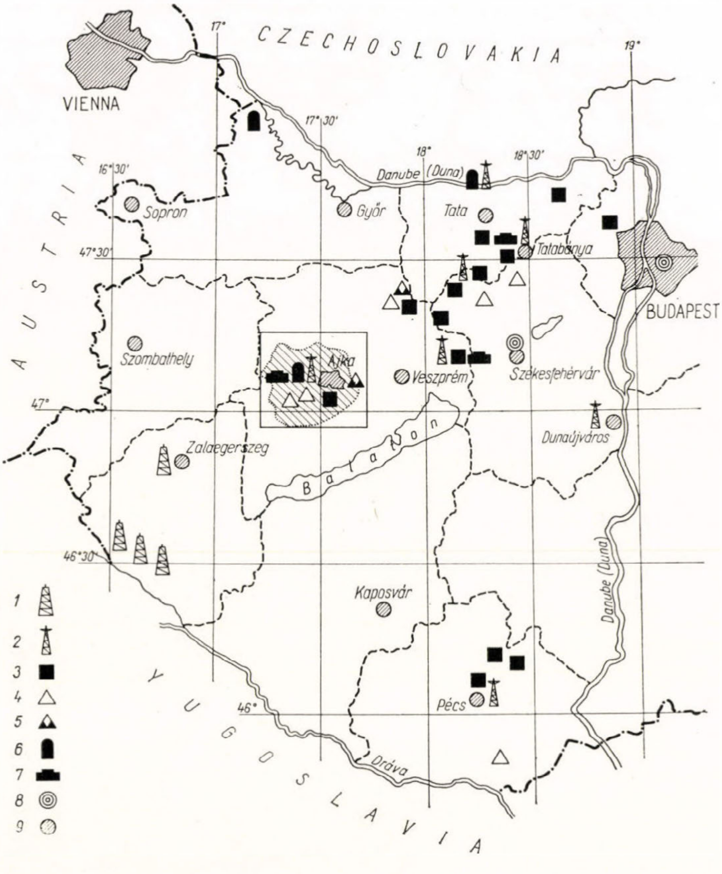

FIG. 1. Sites of the Transdanubian coal and bauxite mines, alumina and aluminium plants

1 = oil; 2 = major power station; 3 = coal; 4 = bauxite; 5 = manganese; 6 = alumina works; 7 = aluminium furnace; 8 = aluminium rolling mill; 9 = major towns

the Bakony Mts are characterized by a block-faulted structure. In fact, the southern Bakony is articulated into blocks dissected by fault troughs and intensively denuded plateaus. It follows from the block-faulted structure that the coal seams and the bauxite lenses are also fragmented by faults.

At the turn of the Pliocene and Pleistocene clay deposits of various quality, suitable for pottery, were formed on the confines of Városlőd, 5 km far from

Ajka. Evidence of Pliocene volcanism is present in the form of some basalt cones and sheets.

The climate is strongly influenced by the fact that the main strike of the northern (or High) Bakony, emerging north of the Devecser tectonic line, is normal to the predominant north-western direction of winds. So the area is sheltered from the winds, though it lies at 250 to 300 m a. s. l. high (9 to 10 °C). The area is situated in the rain shadow; nevertheless the precipitation of 550 to 650 mm annually corresponds to the national average, because the secondary Mediterranean rainfall maximum is more prominent here than in the other areas of the country. The precipitations which were sufficient for the formation of forests and for agricultural production in the past, do not meet the needs for industrial and drinking water of the developing region. They quickly disappear in the haircracks and karst labyrinths of the limestones and dolomites.

Surface water streams are scarce. The water regime of the brooklets Csinger and Tarna is extremely unpredictable, being entirely dependent on local precipitations. Now the surface streams of the Ajka area are practically sewage waters.

The karst waters are always dangerous for both coal and bauxite mining, especially as exploitation effected below the karst water level in most of the shafts goes on penetrating deeper. The mines have been completely flooded by karst water several times. It has not yet been clearly decided whether, by a further development of mining, requiring the opening up of new shafts and a material lowering of the karst water level, the water economy of the adjacent areas will not be endangered to such a degree as to jeopardize agricultural production there. On the other hand, the karst waters largely contribute to the water supply of the industrial plants and the population. The possibilities for tapping artesian waters are very limited. As a partial solution, a water pipe has been built to convey water from a profuse karst spring (Lake Tapolca near Pápa at the northern fringes of the Bakony) across the mountain range to Ajka.

The soil conditions are not suitable for any proficient agriculture. The rendzina and podsol, as well as the bleached and brown forest soils preserved at the sites of logged forests, are subjected to continuous erosion.

Natural vegetation is encountered only in thin and scattered traces on pastures, embankments, etc. The forests are managed according to scheduled plans. On the warmer, southerly slopes oak, in the higher-seated tracts beech predominate, but in time the less exigent hornbeam is likely to supplant both species.

In the various stages of historical development, the above-discussed properties, conditions and limitations of the physico-geographical environment were reacted upon by the population in different ways. Till well into the 1860's, the maximum harnessing of the natural resources consisted, beside extensive agriculture, in pig holding based on masting, also in logging and charcoal- and lime-burning. The great economic and industrial upswing which took place throughout Europe in the last third of the 19th century—referred to as the *Gründerjahre* in Germany—started at about the same time in Hungary, too. With the development of the railway system, the needs for coal increased progressively, and this in turn required the opening up of new coal mines. Ajka's first boom also started with coal mining (Fig. 2).

The coal seams at Ajka were deposited in several phases in the lagoons of the freshening Cretaceous sea, under the tropical-subtropical climate of the Upper Cretaceous. This process brought about seven seams of different faces

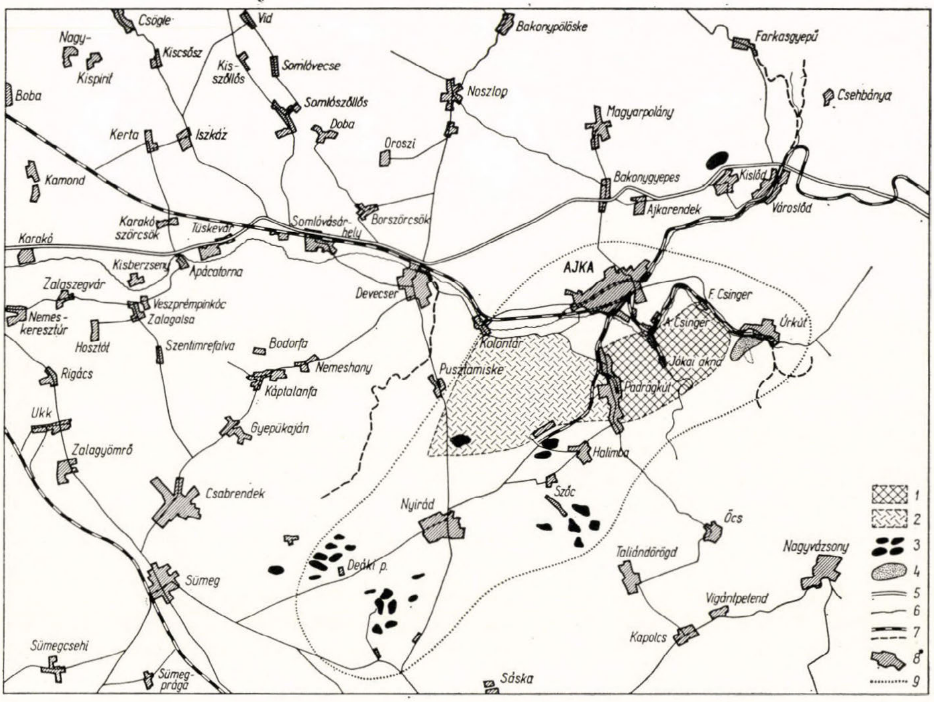

FIG. 2. Settlements, mineral deposits and arterial roads of the Ajka area

1 = exploited coal fields; 2 = supposed coal fields; 3 = bauxite; 4 = manganese; 5 = arterial roads; 6 = roads 7 = railways; 8 = settlements; 9 = boundary of the Ajka district

and thicknesses, locally 50 to 60 cm, while at other places they are about 4 or 5 m thick. Parts of them lie below the karst water level. The thickness of the coal seams totals 16 to 20 m. The seams strike from E to W and dip from NE to SW. They are continuously broken by closely spaced faults. Prior to World War I, the coal resources of the region had been estimated at only 1.5 million tons. However, in 1960 the total amount of proved and measured resources was found to be 80 million tons.

Although the coals at Ajka are much older than the Eocene and Oligocene coals of the Tatabánya Basin north of Ajka, they are of a poorer quality, since the geological conditions had been unfavourable for their carbonization. Nevertheless, in Hungary they are regarded as brown coals of good quality, with a calorific value between 2600 and 3400. Their qualitative parameters are, in addition, relatively low tar and ash contents. In the early days, of course, only the coals of best quality and highest calorific value were exploited.

After the seventies of the last century, four shafts were sunk in the valley of the Csinger brook. Three of them are still at work today (Lower Csinger, Upper Csinger and Jókai mines). During World War II, two new shafts were laid at Padragkút: Hunyadi and Táncsics. At present, 8 shafts are operating in four mines of the coal basin.

At the end of the last century, annual production was only 45,000 tons; it reached 150,000 tons by the time of World War I and mounted to 700,000 tons in the course of World War II. Later on, after a temporary decline, it went up quickly, partly as a result of new shafts being opened up. In 1949, production reached 900,000 tons, and in 1962 it exceeded 1.6 million tons.

After Liberation, the number of workers grew at a swifter pace than production, owing to the introduction of the eight-hour shift in place of the twelve-hour shift. From 1950 on, however, progressive mechanization resulted in a slower increase of labour as against the rise of coal output. At present, some 5,000 persons are working in the collieries of the Ajka area; 1,800 of them are underground workers. Compared with the other mines of Hungary, productivity is fair; however, in calorific value it lags rather behind the results current in Germany and Poland. The increase in production is naturally accompanied by a decline in quality, since not only the best seams are worked. This is not a significant drawback, as the equipment of the power station has been designed for fuel of low calorific value, and the mines are able to supply the station with unlimited coal of satisfactory quality. The coal of higher quality is used for other purposes, partly in the area of Ajka, partly in other regions.

The coal-mining operations — especially haulage — were largely mechanized after Liberation. The pick was everywhere replaced by the chipping hammer, and room mining, where possible, by regular longwall coal-winning. Mechanical cutters are used where the tectonic conditions are suitable. Since, however, the seams are intensively faulted, neither the longwall system nor the cutters can be applied everywhere. Coal is drawn out almost exclusively by conveyors and transported from the three mine heads by three aerial conveyors, respectively 4—6—8 km long, to the central separator of Ajka. This separator was built in 1954, close to the biggest consumer, the electric power station.

80% of the coal extracted is made use of by the power station, 10% by local industrial plants; the rest is transported out of the area. Because of the great distance of the coal seams from any housing settlements, a housing programme was developed close to the mines in the Csinger Valley.

The bauxite deposits of the Ajka area were discovered before World War II, in the 1930's. As to the size of the bauxite resources, only very rough and unreliable estimates had come to light before Liberation, especially prior to World War II. Because of the lenticular structure of the bauxite deposits, no reliable method of estimation of their extent can be applied, as in the case of coal seams. An exact appraisal of the bauxite resources is only possible by a scientific evaluation of a dense network of sampling points. Anyway, the earlier far-fetched estimates were due not to the errors of specialists, but rather to the syndicates attempting to use them for speculation in the course of the armaments drive in World War II. After Liberation, investigations made by means of scientific and technical methods indicated lesser resources. The technique of exploration is actually so advanced that in future no surprising changes as to the estimated size of the resources need be reckoned with.

The total amount of the proved and measured bauxite reserves of Hungary exceeds 120 million tons. The Ajka area's share of the national bauxite deposits is about 60 million tons, i.e. approximately 50% of the total resources of Hungary.

The Ajka bauxite deposits are characterized by a high Al_2O_3 content, which, however, does not determine the quality of the bauxite. The quality is defined by the module which expresses the quantitative ratio of Al_2O_3 to SiO_2. This content is also high: to be specific, the percentage of the alumina content is at least ten times as high as that of the silica content, i.e. the value of the module is usually above 10. Additional characteristics of the bauxites in the environs of Ajka are a high iron oxide (FeO_2) content of about 25%, together with the comparatively high proportions of titanium, vanadium and gallium (Table I).

TABLE I

Composition of some Hungarian bauxite types

	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	H_2O	Kaolin	Hydrar-gillite	Boeh-mite	Goe-thite
Halimba	43.08	2.88	27.79	1.87	23.37	6.2	62.0		10.0
Nyirád	64.59	0.24	9.37	1.87	21.93	4.8	43.5	41.0	—
Gánt	64.90	0.38	17.64	3.46	13.54	0.8	8.5	69.2	—

Major bauxite centres in the environs of Ajka are Halimba, Szőc and Nyírád. Some 40 lenses are known to be situated within a circle with a radius of 10 km, partly close to the surface, partly at relatively shallow depths (40 to 60 m) which are accessible by inclined adits. Only the deep-seated and large lenses have required the sinking of shafts. Between 1943 and 1962, 23 mines were opened up in the central area. At present fourteen are in operation, three of them being opencast. A new, large opencast mine is being developed at Kislőd, north-east of Ajka.

Large-scale mechanization is possible only by opencast mining. Since it is unfeasible to develop a separate shaft or inclined adit for each lens, the comparatively close-spaced shafts are connected by galleries, and bauxite is hauled up through a central hoisting shaft.

Since Liberation the bauxite production of Hungary has been steadily increasing; the contribution of the mines in the Ajka area to the national output becomes more and more considerable, as shown in Table II.

Table II

Bauxite output and exports of Hungary and of the Ajka area (Nyirád, Szőc, Halimba)

Year	Hungary		Ajka area	
	Output	Exports	Output	Workers and employees
	in 1,000 tons			
1938	540	362	—	—
1946			25	—
1949	561	326	143*	490*
1955	1241	554	550	1594
1956	892	376	470	1705
1957	907	467	461	1570
1958	1049	538	569	1664
1959	957	466	562	1643
1960	1190	499	724	1738
1961	1366	701	756	1663
1962	1473	719	855	1710
1965 (as planned)	2000	—	1080	1156
1970 (as planned)	2500	—	1720	1575

*1950

The transportation of the bauxite extracted raises particular difficulties, despite the fact that the mines at Nyírád, for example, lie only 18 to 20 km away from the alumina works of Ajka. Initially, bauxite was conveyed by aerial conveyors to Zalahaláp, the next railway station, from where it was transported by a long roundabout haul (86 km) to the alumina works at Ajka. After Liberation, a new railway line was laid to Halimba, where a central loading station was also built; but it was not extended to the mines of Nyírád, lying farther off but having more abundant resources. This was due in part to the rough topography, and partly to the scattered situation of the mines. In fact, no matter where the terminus of the branch line may be located, the bauxite in transport is bound to be reloaded repeatedly. But under the present conditions, the need to avoid frequent reloadings seems to be rather pressing. Therefore, the loads from the mine are now carried by lorries or dumpers directly to the bauxite store of the alumina works of Ajka. Only the shipments for other alumina works or for export are conveyed to the loading stations at Halimba, where the bauxites of different modules are mixed, according to the customer's requirements. This way of transportation can by no means be regarded as a satisfactory one. When the scheduled plan of development is completed, an approximately tenfold increase of production would necessitate too large a rolling stock, which, in turn, would overburden the roads. Hence, the only practicable solution is to construct a suitable system of aerial conveyors.

It was found absolutely necessary to build housing projects for the workers close to the bauxite mines, just as was the case with the collieries. The present settlements, small and scattered as they are, can meet the material and cultural demands of the population only at a very low standard. Consequently, the tendency is to house the miners in the central locality, i.e. in Ajka, providing at the same time modern means of rapid transit for their daily commuting to and from work.

The manganese ore deposits near Úrkút, a village at a distance of 8 km from Ajka, was discovered before World War I. Exploitation was started by opencast mining, working the outcrops, which later, between the wars, was replaced by underground mining when an inclined adit and two shafts were developed. The ore is delivered only after being enriched in the local ore-dressing plant. Geological prospectings and borings have subsequently been made of some more ore deposits, and now the resources of Úrkút are estimated to be some 40 million tons. Although deposits are far smaller than those known in the Soviet Union, still this output takes second place in Europe. Earlier, for the most part, oxidic ores of a good quality had been extracted, but the bodies discovered later were carbonate ores with a less pure manganese content. By a new method, however, these ores can be enriched, too. Hence, Hungary not only supplies her domestic market, but also will be able to export considerable amounts of manganese. As the utilization of the bauxite iron of Ajka has not yet been effected, it stands to reason that a ferro-manganese furnace should be built, whether at Úrkút or at Ajka, where the bauxite iron might be worked up as soon as the technology and economic conditions for this can be developed. It is worthy of mention that another manganese ore mine is being operated near the village Eplény, in the Bakony Mts, but its resources equal only one tenth of those of the Úrkút mine.

The manganese mines of Úrkút employ 980 workers. But because many inhabitants of Úrkút go to work in the near-by collieries where they get higher wages and better working conditions, the manganese mines of Úrkút therefore have to rely on in- and out-commuters from outline communities.

After Liberation, growing production at Úrkút required construction of a large-scale housing project. According to the long-term plan, the employees of the manganese mine will also be housed in new flats in the central settlement—Ajka.

A geological peculiarity in the Úrkút manganese mine is the great abundance of quartz sands of an excellent quality. Their pure silicium content as shown by analyses amounts to 99.5%. The predecessor of the Ajka glass works that was established at Úrkút at the end of the 18th century may have used these sands as raw materials. But as the modern glass works has used imported quartz sands for several decades, the presence of such sands at Úrkút is now regarded rather as an impediment to manganese mining.

The glass works is one of the biggest and oldest plants at Ajka. Following its complete re-construction between 1960 and 1962, its production and workers and employees were doubled, and by 1963 the number of its employees had reached 1,000. Just as with the power station and the alumina works, nearly 50% of the employees of the glass works are not residents, but must commute from 57 surrounding localities.

The glass works manufactures pressed glass and fine white and coloured household glass. The quartz sand used is imported from Hohenbocka in the German Democratic Republic. 85% of the manufactured glassware is exported. As the imported glass sands cost only some 10,000 Fts in 1962, while the value produced by the factory was 80 million Fts, it is obvious that the importation of sands is by no means unprofitable. The sands of Úrkút, however, should be transported and made use of by other glass factories. So their utilization may result in material foreign exchange savings.

The erection of a combine, in the early forties consisting of power station, alumina works and aluminium furnace, gave the initial impetus to Ajka to become a significant industrial settlement. This development was speeded up by the high demand for aluminium immediately before and during World War II. The circumstances surrounding the construction of the combine reflected the social structure of the feudal-capitalistic Hungary of the time. The state carried out an illusory land reform, however, not for the benefit of the small peasants who were given the land, but first of all, the big landowners profited from it, who offered parts of their estates for the purpose. The state purchased the land to be distributed, and thus considerable capital was obtained by the big landowners in the Bakony region, as well as the Episcopate of Veszprém and the Abbey of Zirc, who then invested that capital and additional government loans in the foundation of the Hungarian Bauxite Mines Corp. The alumina works designed for a capacity of 20,000 tons per year and the aluminium furnace envisaged, in compliance with the former, for an output of 10,000 tons per year, were built at a site favourable both for coal and bauxite transport from the mines.

Since electric current is the most costly factor of aluminium production, the combine has had to be completed with an electric power station which can supply the alumina works also with steam. The power station was erected by the United Incandescent which belonged to the pool of the General Electric Corp. which was concerned with the mines of the Ajka area. It was built in the immediate vicinity of the furnace and alumina combine, in order to avoid current and heat losses. When locating these three plants, provision was made as to their further enlargement. From this point of view, the combine of Ajka may be considered as having an exemplary location. In fact, the enlargement was carried out without any difficulty after Liberation.

By the end of World War II, the construction of the power station, alumina works and aluminium furnace was nearly completed. Full operation and running-in, however, were delayed by the war, so the plants reached their planned capacity as late as 1949.

Since the power station was planned to supply the aluminium furnace with electric current and can in addition produce 3 to 4 times as much steam as is required for the operating of the furnace, thus by freeing this steam for manufacturing alumina, the annual capacity of the alumina works was increased from 20,000 to 60,000 tons shortly after the running-in of the plant. The actual output of the alumina works, however, exceeds the theorectical capacity by more than 20%. By some slight enlargements, i.e. by improving the technology and abating the specific current consumption, the alumina works would be enabled to yield 50% more above its initial capacity (Table III).

The quick increase of coal production and a country-wide power transmission network have made it possible to augment the power station output, so its actual capacity is 150 MW, in contrast to its initial 45 MW.

Table III

Output and exports of alumina and ingot aluminium (in 1,000 tons)

	Hungary				Ajka	
	Alumina		Aluminium		Alumina	Aluminium
	Output	Exports	Output	Exports	Output	
1938	6.7	2.7	1.3	—	—	—
1943	—	—	—	—	6.5	1.3
1946	—	—	—	—	1.6	0.3
1949	30.6	2.2	14.4	3.5	17.1	9.6
1955	154.1	79.1	37.0	9.2	28.8	10.1
1956	153.4	88.6	34.8	6.0	42.7	10.3
1957	154.2	89.5	25.1	1.9	42.6	10.0
1958	169.7	86.7	39.5	17.3	48.0	12.6
1959	191.6	114.6	45.7	8.4	55.5	15.3
1960	218.0	121.0	49.5	9.8	63.3	15.3
1961	224.0	144.0	51.1	7.7	65.7	15.3
1962	233.0	126.0	52.7	6.0	71.0	15.1

The most important factor of the industry of the Ajka area is the combine of power station, alumina works and aluminium furnace, which employs 4300 persons. If we add to this figure the employees of the coal separator, the number is 7,800 for the town and 12,000 for the area.

The industrial plants of the town employ mainly male labour. Hence, it is urgent to erect plants to employ primarily female labour. A factory manufacturing television components has already been built with a view to this requirement. At present it has only 500 employees, but according to plan by 1965 the number of female workers will exceed 1,000. Some additional production facilities will be made available for the employment of female labour.

During the last twenty years, and especially the last decade, the economic and social development of Ajka and its region has been determined by the increasing production of the power station, the alumina works and the aluminium furnace, and the bauxite mine. This progress is still far from reaching its peak.

For a better understanding of the perspectives, the situation of the industry of Ajka must be elucidated in relation to the complexity of the bauxite-aluminium problems of Hungary.

Of the world's bauxite resources amounting to 1.6 to 2 thousand million tons approximately 12% is found in Hungary, almost exclusively in Transdanubia. Since Hungary is comparatively poor in mineral resources and especially in raw materials for heavy industry, bauxite is of a very great importance for her national economy. Problematic is, however, the processing of bauxite into aluminium. In fact, to produce 1 ton of aluminium requires roughly 2 tons of alumina which, in turn, can be obtained from 5 tons of bauxite. The alumina (Al_2O_3) is extracted from the bauxite by a chemical process requiring little current (500 kW-hours per 1 ton of alumina) but a great deal of steam (4 to 5 tons per 1 ton of alumina). The alumina then is charged into the electrolyzers of the aluminium furnace where pure aluminium is obtained. However, the production of 1 ton of pure aluminium requires, as a rule, 18,000 kW-hours of electric current. So, electric current is the most important cost factor of aluminium metallurgy. Therefore the trend all over the world is to minimize the specific current consumption by generating electric current with the comparatively less expensive water power.

In this respect, quite remarkable results have been achieved by the metallurgists of Ajka, who were successful in reducing the specific current consumption per ton of aluminium below 18,000 kW-hours. As, however, the exploitable water power resources are scant in Hungary, and the prime costs of electric generation are high, — much higher, e.g. than those of the big Soviet and American hydro-electric power plants, — it is not profitable to carry out both phases of total aluminium production at home. But it does not pay to transport the raw bauxite great distances, either. Considering the existing possibilities, the best solution seems to be gearing Hungarian plants primarily to alumina production. A small portion of total alumina should be retained for domestic processing; the rest should be sent abroad to be smelted by international co-operation, or exported according to international compensatory trade agreements. Thus co-operation may be possible through joint harnessing of the water power resources of the Carpathians or the Middle Danube Basin in the areas of Czechoslovakia (Slovakia), the Soviet Union (the Carpathian Ukraine), Rumania (Transylvania) and Yugoslavia (the Drava Belt). In this event the sites of resources and processing could be within a radius of cca 200 km. However, until such international co-operation is developed, Hungary will greatly increase the production of her alumina to be smelted in the Soviet Union by virtue of the terms of Hungarian—Soviet Bauxite-Aluminium Agreement concluded at the beginning of 1963. All the aluminium thus produced will be returned, and Hungary will pay for the smelting and transportation costs by delivering home-produced commodities.

Ajka will play a particular role in this long-term plan, as the bulk of the alumina for export will be produced by the alumina works of Ajka, from bauxite mined in the Ajka area. According to current plans, the Ajka area's bauxite output of 750,000 tons in 1961 will grow to 1.7 million tons by 1970. The capacity of the alumina works will be increased from the present value of 60,000 tons to 120,000 tons, and a new factory with a capacity of 500,000 tons will be built.

It would be, however, an error to ignore the by-products of alumina production and aluminium metallurgy. The so-called red mud left over after alumina is extracted from the bauxite contains a high percentage of iron, vanadium, titanium and gallium. The technology of recovering vanadium has been solved, and experiments with titanium are under way. For several years the so-called "four mines gallium" with a purity of 99.99% — a most important semi-conductor, the world market price of which exceeds that of gold — has been turned out by several hundred-weights per year in Ajka. It is utilized partly by the domestic industry, partly for export. By further improvement of technology, gallium of 99.999% purity and possibly 99.9999% will be obtained. Bauxite iron, ferromanganese, vanadium, titanium and gallium products will increase in volume parallel with the increase of bauxite and alumina.

The large-scale exploitation of the carbonate manganese ores at Úrkút, and their enrichment by a new method, is the second most important production activity in the development of the Ajka area. This not only enables Úrkút to supply the Hungarian steel industry with manganese, and possibly with ferromanganese alloys, but also leaves considerable amounts for exports.

Accordingly, the international co-operation of the socialist countries, i.e. the international division of labour, permits increase in Hungary's alumina and aluminium production, especially that of the Ajka area, to a degree that was impossible under capitalistic conditions prior to Liberation. The development of the bauxite-aluminium production of Hungary and especially Ajka, and the industrial transformation of the Ajka area, demonstrate fairly well that international geographical division of labour, as well as conditions of production, are decisive factors in the social and geographical division of labour of a country.

As a result of the development we have outlined, the number and the composition of the population has fundamentally changed in both Ajka and its area (Fig. 3).

All over the world, but particularly in the socialist countries, the growth of mining and industrial production has caused such a rapid increase in the number of workers and employees that the industrial settlements, especially the towns, have been unable to keep pace with it. For this reason, great masses of labour have to commute daily or weekly to and from work in every quickly-developing country. This is the case with the Ajka area and other industrial regions of Hungary. The distance covered by the commuters mainly depends on the available roads and development of transportation. But irrespective of the state of the communication network and type and number of vehicles, commuting will always occupy additional rolling stock, absorb fuel and time; and it unnecessarily tires the labourers. So the majority of the workers should live in proximity to the working places. This is desirable not only for social and economical reasons, but also from technical considerations (Fig. 4).

However, to continue to build housing near the mine plants scattered throughout the Ajka area would only result in minor settlements of a rural character, wherein the workers would not be able to satisfy their increasing material, social and cultural demands. Since in the case under discussion the overwhelming majority of the active population work in Ajka itself, it appears to be most reasonable to further develop the residential quarters in the town, so that the least number of the total workers should have to use the daily commuting facilities from the town to the outlying mines. Hence transport, though not altogether eliminated, will by all means be largely reduced. The long-term plans take into consideration all these requirements. Nevertheless, four additional points must be kept in view:

(1) The overwhelming majority of the commuters live in rural settlements. They and their families mostly have two occupations; their main income derives from industry, but some members of the family also live by the proceeds of agriculture. In Germany, similar circumstances result in the phenomenon

of *Sozialbrache* (social waste); the rural population migrating into industry leaves the lands uncultivated. In Hungary, agriculture is based on collective work; consequently no Sozialbrache can be engendered. In fact, the possibility exists for the whole family to surrender their land to the co-operative farm, against payment of land rent, when they wish to move into town.

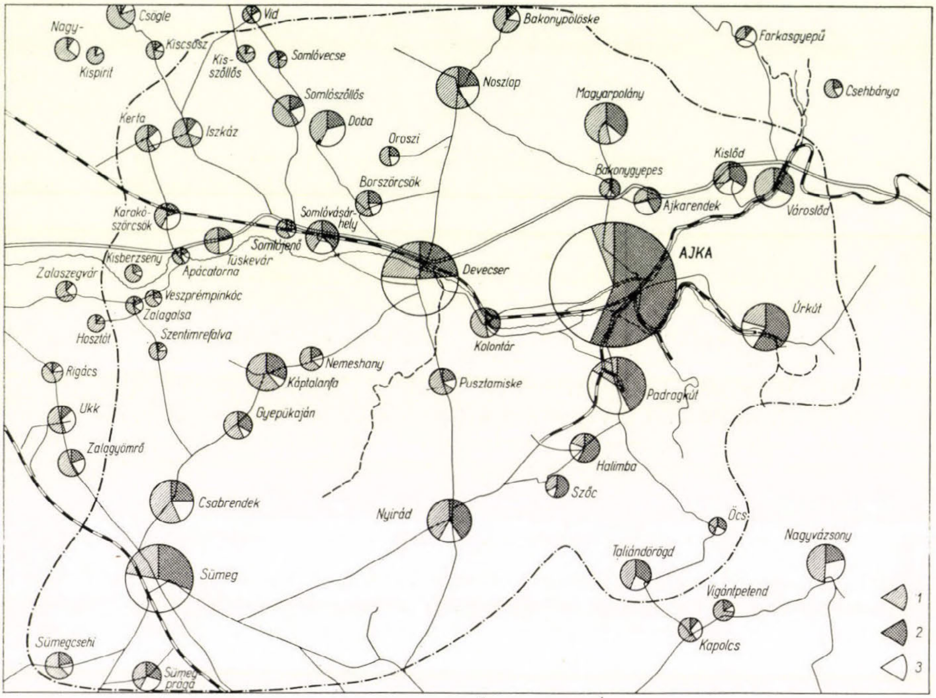

FIG. 3. Occupational division of the population of the Ajka area by settlements
1 = agriculture; 2 = industry; 3 = "other"

(2) Another obstacle to moving into town is that female labour, previously workers on the "household plot" or on the co-operative farm, can hardly find employment in town. Therefore a serious objective of town development is erection of plants specifically for employing female labour.

(3) No complete solution will be achieved in this way either, since many nations' experience has shown that former villagers have an aversion to tenement houses or apartments, and prefer to live in cottages with gardens where they can raise poultry, pigs and grow vegetables in leisure-time for quasi amusement. This bias, which is very strong in Hungary, has to be reckoned with by town planners. So urban development has to proceed in two parallel ways: (a) blocks of flats, and other houses of established urban character should be built; (b) well-arranged housing estates or suburbs, serviced with all public utilities, will be developed.

(4) A further expansion of industrial production will bring about a big increase of the consumers' demands. So far, statistics show the average wages of miners and industrial workers to be 15% higher than the national average. If both the increase in the actual wages of the plant workers, and also the sums involved by the plan of a further town development, are considered,

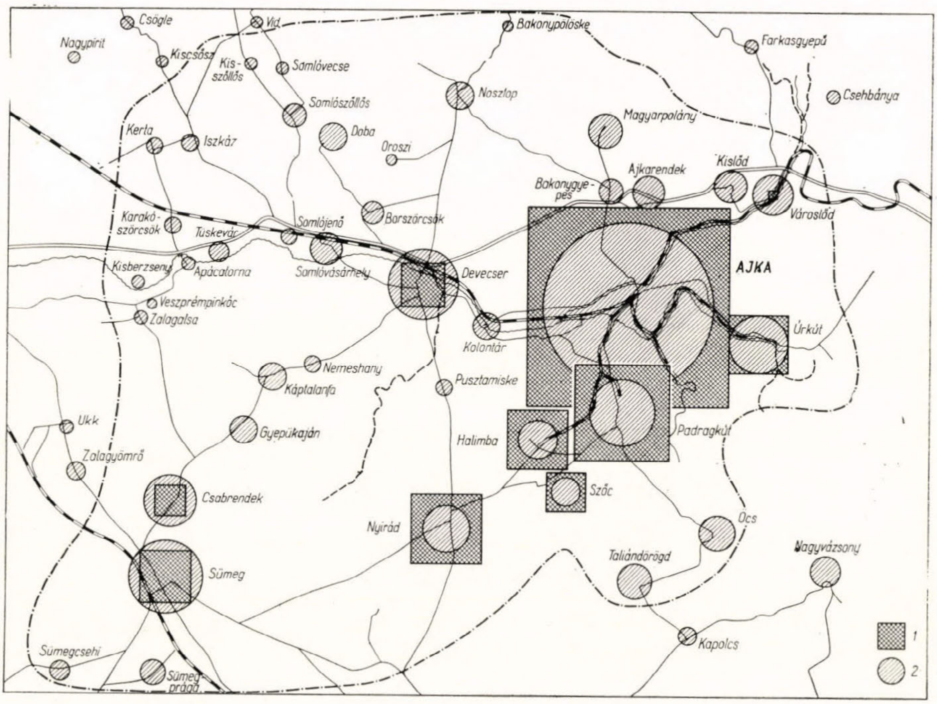

FIG. 4. Population gainfully occupied in mining and manufacturing industry; employees of mines and industrial plants by settlements:

1 = 100 resident industrial breadwinners; 2 = 100 industrial employees

even more striking discrepancies are to be expected. By the employment of female labour, the income of families will also be raised by leaps and bounds. All these will tend to bring about a parallel increase of urban demands, which will exceed the rate of growth of industrial production. Not only schools, hospitals, nurseries, creches are to be established, but also the volume of trade is to be augmented by networks of shops and new stores. Further, cultural demands of the population are to be met by providing new cinemas, theatres and other places of amusement, or by improving the existing ones.

Such an organizational plan for the town's growth, however, raises extremely complex problems. As shown in Fig. 5, the development of Ajka necessarily proceeded at random during the past decades. The mining and industrial enterprises at Ajka and its surroundings provided housing according to their exclusive interests. The housing estates of the collieries were built rather far from the original village (Ajka) so their occupants were deprived of all material and cultural amenities, provided there had been any such amenities available in the locality, then entirely of rural character. Along with the housing started at the turn of the 20th century, hundreds of cottages were built in dispersed, disorderly fashion between the mine plants and the village. The anarchy was intensified at the beginning of the forties, when the alumina works and the power station started to build their own housing estates, regardless of each other's interests and the long-range perspectives

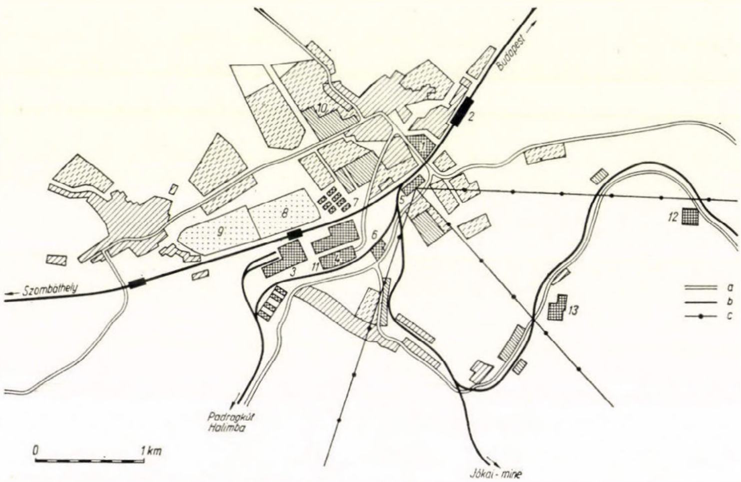

FIG. 5. Schematical layout plan of Ajka:

a = highway; b = railway; c = cableway. 1 = glassworks; 2 = railway station; 3 = alumina works and aluminium furnace; 4 = power station; 5 = coal separator; 6 = bread-making factory; 7 = TV factory; 8 = slag heap of the power station; 9 = red mud depot; 10 = housing estate of the alumina works and the aluminium furnace; 11 = housing estate of the power station; 12 = Felsőcsinger mine plant; 13 = Alsócsinger mine plant

of town development. The number of houses built was very limited. One of these two estates is situated in the immediate vicinity of the power station, south of the railway line, the other 2 km to the north. Not until the beginning of the fifties did a material enlargement of the housing estate of the alumina works prove to be well planned; so it was the first phase of a subsequent housing programme. Although this process went on at a slow pace during the fifties, a quarter of the entirely new and urban character desired has come into being in the vicinity of the old, underdeveloped rural settlement, the primitive mining colonies, and the somewhat more up-to-date housing estates of the power plant and the alumina works. This was later added to by the new and extensive estate of miners' houses, built in 1957 and 58.

Owing to new privately-owned housing, the built-up area of Ajka progressively expanded, and the town finally reached and absorbed the neighbouring localities of Tósokberénd and Bódé.

Consequently, it devolves on town-planning and development to fuse these heterogeneous parts into a settlement as uniform as possible with regard to townscape, architecture, communications, and social and cultural amenities. A considerable part of the old settlement will be reorganized. Old, dilapidated houses, except for those of historical significance, will be pulled down. A new town centre may thus develop which will have a direct and organic connection with both the existing modern quarter and the housing estate of the alumina works. This nucleus of distinctly urban type will be surrounded by zones of cottages with gardens. So it will be possible to satisfy the diverse housing demands within a fairly restricted area, and to secure urban standards of living for most of the population.

TEN YEARS OF PHYSICOGEOGRAPHIC RESEARCH IN HUNGARY

(STUDIES IN GEOGRAPHY NO. 1)

by
MÁRTON PÉCSI
D. Sc.

This book covers the research work carried out in physical geography by the Geographical Research Institute of the Hungarian Academy of Sciences during the past ten years. The reader is acquainted with the detailed results of the Hungarian geographers' investigations into surface features resulting from fluvial erosion, deflation, slope movements, peneplanation, recent crust movements and periglacial processes. Information is given on research in loess morphology, terrace morphology, quaternary chronology. The trends and fundamental methods of applied geography and the conception of Hungarian morphological mapping are also dealt with. A detailed bibliography of the science of physical geography in Hungary is appended.

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